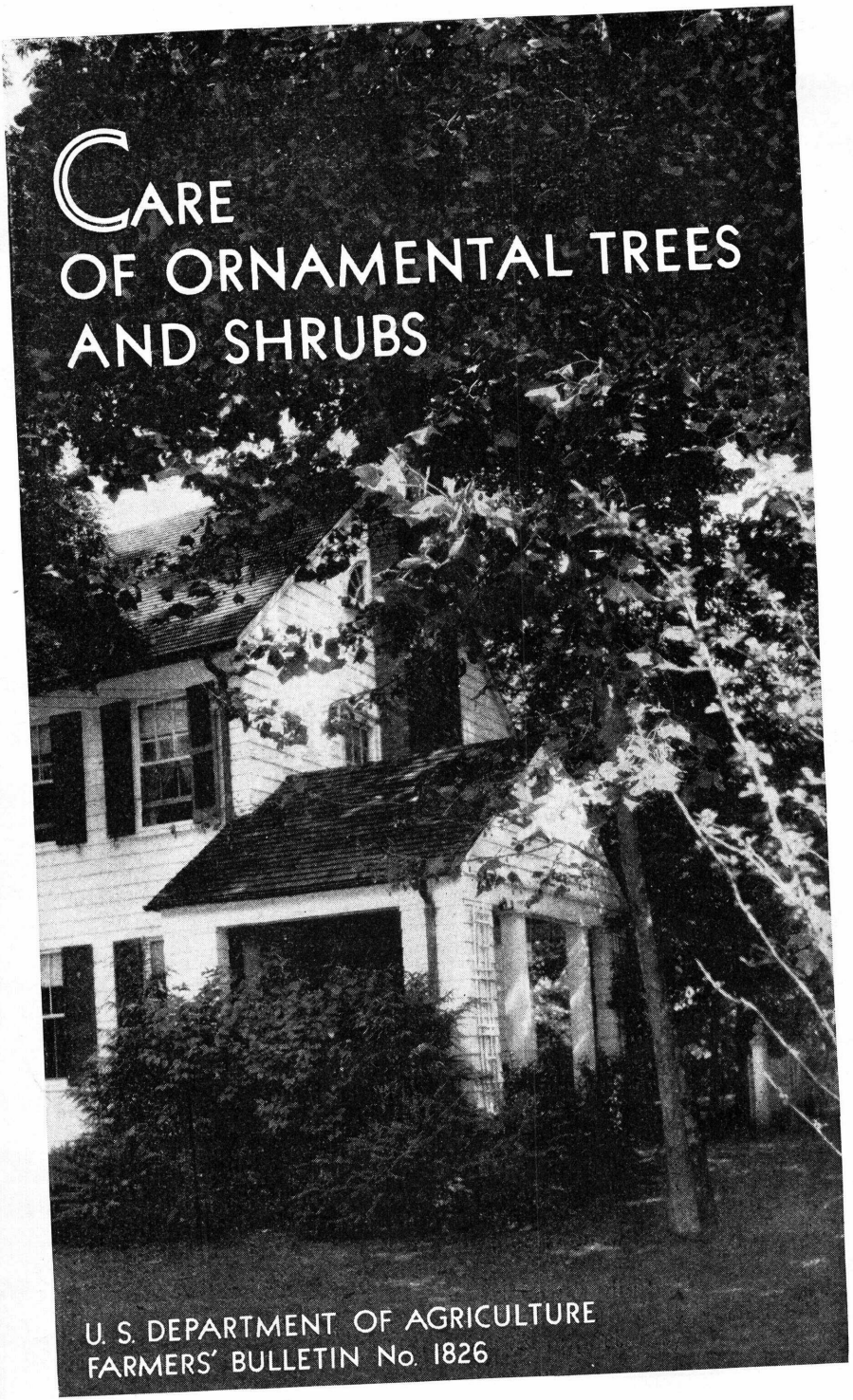
CARE
OF ORNAMENTAL TREES
AND SHRUBS
U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1826

TREES AND SHRUBS growing in places frequented by men add to the joy of life if harmoniously placed and kept in vigorous, healthy condition. Health and vigor are necessary if the plants are to add attractiveness to their surroundings. Attractiveness is achieved by selecting trees and shrubs hardy to the region where they are to be grown and suited to the texture, fertility, water content and acidity of the soil, amount of sunshine, severity of winds, and character and amount of air pollution.

Plants suited to airy situations on rich, well-drained soils do not thrive in pockets without adequate air drainage on poorly drained soils; likewise plants that want damp, shady locations are not at home in open, dry places, and those that thrive on poor sandy or gravelly soils may not succeed on rich clay loams.

Man often greatly modifies conditions under which plants are to be grown, not only on his home grounds but also about public buildings, in parks, along highways, and in many other places. Only plants adapted to the conditions in which they are to be grown should be selected. Occasionally it is possible to provide conditions suitable for those plants that may be especially desired. Special care should be given all plants for at least 3 years after they are transplanted; there should then be continual watchfulness that such slight later care as is usually required may be timely. Suitable culture should follow, adequate water should be applied as needed, appropriate fertility should be supplied if there is not moderate, healthy growth, and pruning should be done as conditions require.

Plants in uncongenial surroundings soon assume an unhealthy, unattractive appearance and are much more susceptible to attacks of diseases and insects. A good healthy growth not only wards off many enemies but also helps to minimize the effects in case of attack. Methods of spraying to prevent many injurious attacks are known, but plants subject to severe injury repeatedly should probably not be used.

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CARE OF ORNAMENTAL TREES AND SHRUBS

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CONTENTS

INTRODUCTION

ORNAMENTAL PLANTINGS are made to beautify the surroundings in which they are placed. To be attractive they must have a healthy, vigorous appearance (fig. 1). They will not have such an appearance unless they are adapted to the conditions under which they are growing. They must be able to withstand extremes of cold in winter, heat in summer, and alternations between heat and cold at all seasons; they must be adapted to the food supply, moisture, and acidity of the soil and able to compete with other plants for moisture and mineral foods in the soil and for light and sunshine in the air. Because natural conditions are disturbed and plants are taken into strange environments, suitable surroundings need to be provided if they are to be healthy and vigorous. Culture may aid plants to thrive where naturally they would not succeed, but there are limits that cannot be passed, and it is well to select only those plants known to be successful under the conditions in which they are to be grown. This is important not only on private grounds but even more so in public places.

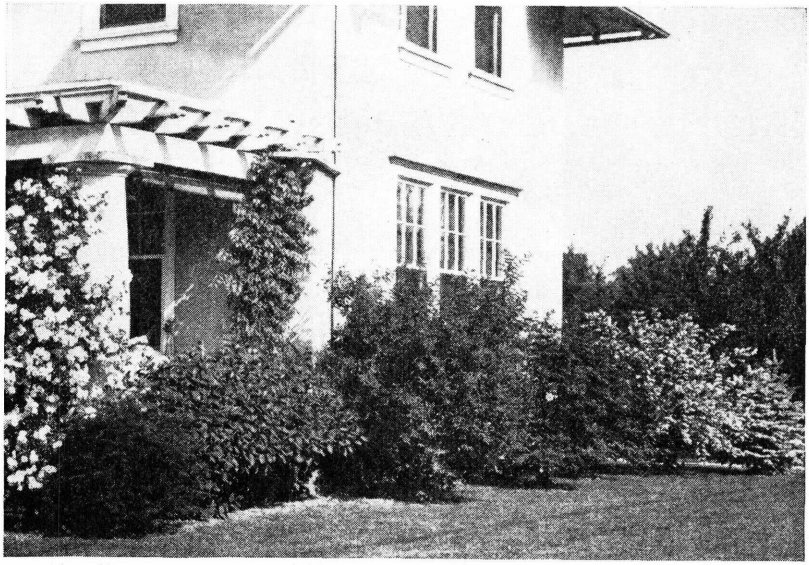

FIGURE 1.—A vigorous appearance is necessary for beauty.

Woody plants used in permanent outdoor ornamental plantings require little attention as compared with lawns, gardens, and herbaceous borders; however, they need timely care, both for their present appearance and future good.

Lack of adequate information has hampered home owners in satisfactorily handling woody plants on their own grounds and has produced especially baneful effects on public grounds where custodians have not realized the need of knowledge and experience for even the simplest operations. Plants are often injured because persons inexperienced in gardening are permitted to hoe and otherwise cultivate the soil and apply fertilizer. These are rather simple operations, but those without experience cannot perform them in a way satisfactory to the plants. The margin between good pruning and that which is ruinous is very narrow; yet many who profess to be pruners have no conception of the underlying principles governing good work. Intelligent, timely care produces the most satisfactory results with the least expense. In the following pages these matters are discussed for different types of woody plants commonly cultivated, whether grown on the home grounds, about public buildings, in parks, playgrounds, or cemeteries, on golf courses, or along highway borders.

CLASSIFICATION

For convenient reference, plants are divided into groups from the standpoint of some conspicuous characteristics. One such classification divides them into herbaceous and woody plants. Herbaceous plants either have no stems or only soft stems without woody fibers. Woody plants have stems built up of woody fibers. They are divided into those that are more or less upright and self-supporting, called trees when they attain large size, shrubs if they are more dwarf in stature,

especially if they have several branches from the ground instead of a single supporting trunk, trailers if they are prostrate along the ground, and climbing plants or vines if they rise above the ground by means of some external support, such as cliffs, walls, frames, or other plants. This bulletin concerns itself only with trees and shrubs, although the same principles apply equally to woody vines and trailers.

There is neither a clear-cut nor an arbitrary distinction between trees and shrubs. A plant that ultimately reaches a height of 10 or 15 feet and is inclined to develop a single stem or trunk is likely to be called a tree, whereas a plant of the same height developing several branches from the root is generally called a shrub. Plants less than 8 feet high are usually spoken of as shrubs irrespective of habit of growth; plants over 20 feet high are ordinarily called trees (fig. 2). Some specimens of a plant species may take the form of a tree; others of the same species may take the form of a shrub.

Another classification of woody plants groups them as deciduous and evergreen. Deciduous plants are those the leaves of which die each fall or early winter, though the dead leaves may hang on until spring. Half-evergreen plants remain green until the middle of winter; three-quarters evergreen plants hold their green foliage until toward spring, and evergreen plants hold theirs until one or more crops of leaves have developed, there frequently being three or more crops on the plant at one time. Evergreens may be again divided into two classes—broadleaf evergreens (fig. 3, *A*) having leaves with broad, flat blades similar to the majority of deciduous plants, and cone-bearing or coniferous evergreens having needlelike or scalelike foliage (fig. 3, *B*). Trees of this latter group bear cones, though the fruits of some of them have a berrylike appearance, and the species of two genera, *Larix* (the larches) and *Taxodium* (cypress),

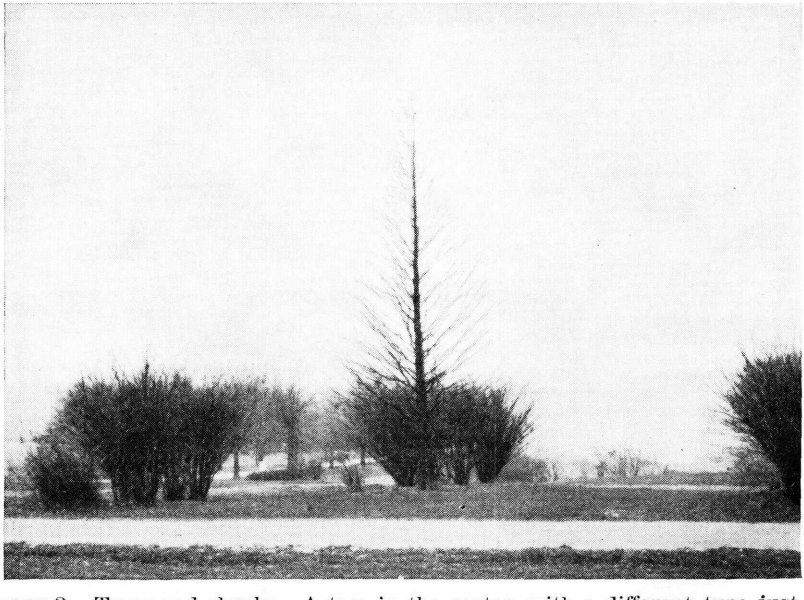

FIGURE 2.—Trees and shrubs. A tree in the center, with a different type just to the left in the distance and shrubs in the foreground.

FIGURE 3.—*A*, Broadleaf evergreens—southern magnolias and boxwoods. *B*, Coniferous evergreens in the foreground; deciduous trees in the background.

drop their needles and so are strictly deciduous, although they are cone-bearing trees.

Some plants behave differently in different localities; for example, the laurel oak is evergreen in Georgia and South Carolina, but hardly half-evergreen in the District of Columbia; similarly, *Ligustrum ovalifolium*, the California privet, is nearly half-evergreen in the District of Columbia in normal winters, but sometimes is almost deciduous and becomes deciduous farther north.

ADAPTATION

HARDINESS

Hardiness is a term usually applied to plants in connection with their ability to withstand cold, but it is as truly applicable to their ability to withstand heat, polluted air, drought, and other adverse conditions.

All plants are not hardy in the same way. One may be injured by cold weather or alternations of heat and cold; another may be injured by extreme cold, but may not be hurt by alternations as long as the cold periods do not go below the minimum of susceptibility; others may be injured by alternations of warm spells and periods of freezing weather, even though the cold weather may not be extreme. The latter are plants that start quickly into growth with a few days' warmth, especially if accompanied by bright sunshine. The summer-flowering or shiny-leaf hydrangeas and the forsythias owe their frequently unsatisfactory behavior at Washington, D. C., Cincinnati, Ohio, and St. Louis, Mo., to this response to periods of warm weather in winter.

Certain plants, including most of the deciduous shrubs of temperate climates, will not succeed unless they have at least one hard freeze during the winter. This partly explains why lilacs and many other northern shrubs and most kinds of coniferous evergreens do not thrive in the South. Some plants cannot withstand severe cold in a wet climate, but can endure very severe cold in a dry climate. The ample moisture of the eastern half of the United States is injurious to many plants that are distinctly satisfactory in the drier regions farther west. Plants that are entirely hardy in any region under normal conditions may be injured if growing weather continues without checking frosts through the fall followed by a sudden drop in temperature to 10° or 12° below freezing. This is what occurred throughout the northeastern part of the United States in December 1911, causing widespread killing back of tops and even outright killing of many plants that are usually hardy.

TYPES FOR DIFFERENT REGIONS

Evergreens in general are well adapted to the moist climate of the East; in the Northeast the cone-bearing evergreens thrive, and in the Southeast the broadleaf evergreens. Very few coniferous evergreens grow well near the Gulf of Mexico and fewer still in the middle of Florida, whereas almost no broadleaf evergreens can withstand the cold of the Northeastern States. More kinds of deciduous shrubs thrive in the North than in the South.

In the drier regions farther west that have considerable freezing weather the deciduous species that succeed are much fewer than in more humid regions; only a few coniferous evergreens thrive and almost no broadleaf evergreens.

Only plants known to be hardy in the region should be selected for ornamental planting because of the extra care required and the unsatisfactory results obtained when species are used that are not adapted to the conditions under which they are to be grown. Those plants are most satisfactory that are native to the locality or to situations similar to that in which they are to be planted. For this reason native plants are frequently recommended. Fortunately, a large proportion of them are as attractive as those brought from other places and have the added charm of seeming to belong to their surroundings when used in conjunction with native plantings, as in natural parks and along public roads. They are valuable also in developing a naturalistic atmosphere when cleared land is being planted. Many exotic plants are fully hardy in each locality and add greatly to the variety about buildings and in more fully developed parks where a natural effect is not the end sought.

Many plants, both native and introduced, thrive over a wide area; others are confined to rather limited conditions. In order that planters may have an idea of those that may be grown, attempts have been made to divide the country into regions within which the growing conditions are similar. One classification divides the country into 32 regions (fig. 4). Plants grown in nurseries in one part of any of these regions should prove hardy in other parts of it.

AIR POLLUTION

Soot and excessive dust are harmful to plant life, some plants being much more susceptible than others. Products of incomplete combustion, including that of soft coal and the fumes from iron works and smelters, are decidedly injurious; products of complete combustion when present in large quantities are also harmful. Dust from cement factories and even from stone crushers is also injurious. Frequent heavy rains somewhat reduce the injury from dust and soot. Lack of success in growing evergreens in some industrial centers is undoubtedly due to both gaseous-vapor and soot pollution. The number of kinds of plants that can be grown to the leeward of many factories and of large cities where soft coal is used in domestic heaters is often quite restricted as compared with the growing possibilities in regions of similar climate not having the air polluted by poisons carried by the prevailing winds.

LIGHT REQUIREMENTS

Plants also differ in their light requirement; some do best in full sunshine, others grow better in partial shade, and still others will grow in strong diffused light with little direct sunlight. On the other hand, many plants that will stand strong sunlight out in the open will be injured if in addition they are subjected to reflections from a building or wall; other plants will stand sunlight and reflections in summer, but may be injured in winter by strong reflections. Protection from cold winter winds and exposure to full sunshine, especially if there is also strong reflected light (fig. 5, *A*), often stimulate plants to begin

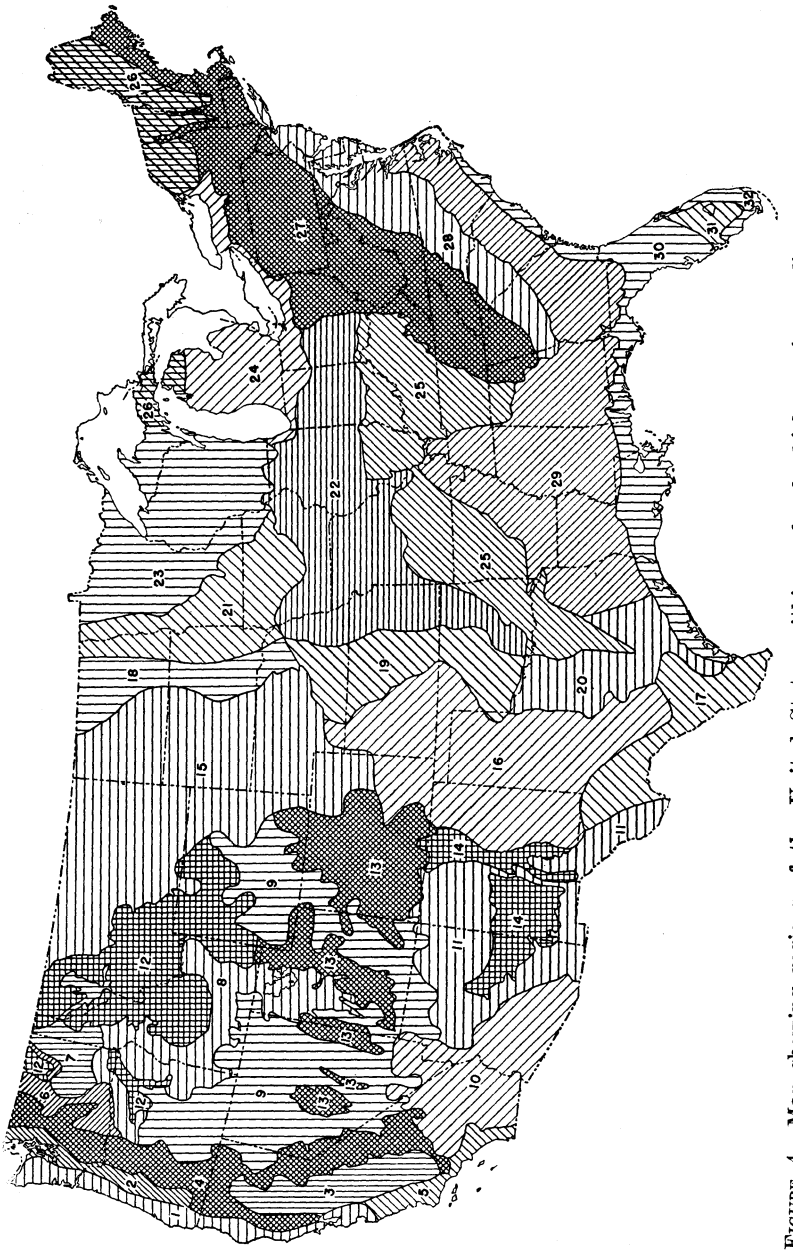

FIGURE 4.—Map showing regions of the United States within each of which growing conditions are similar enough so that the same species thrive throughout.

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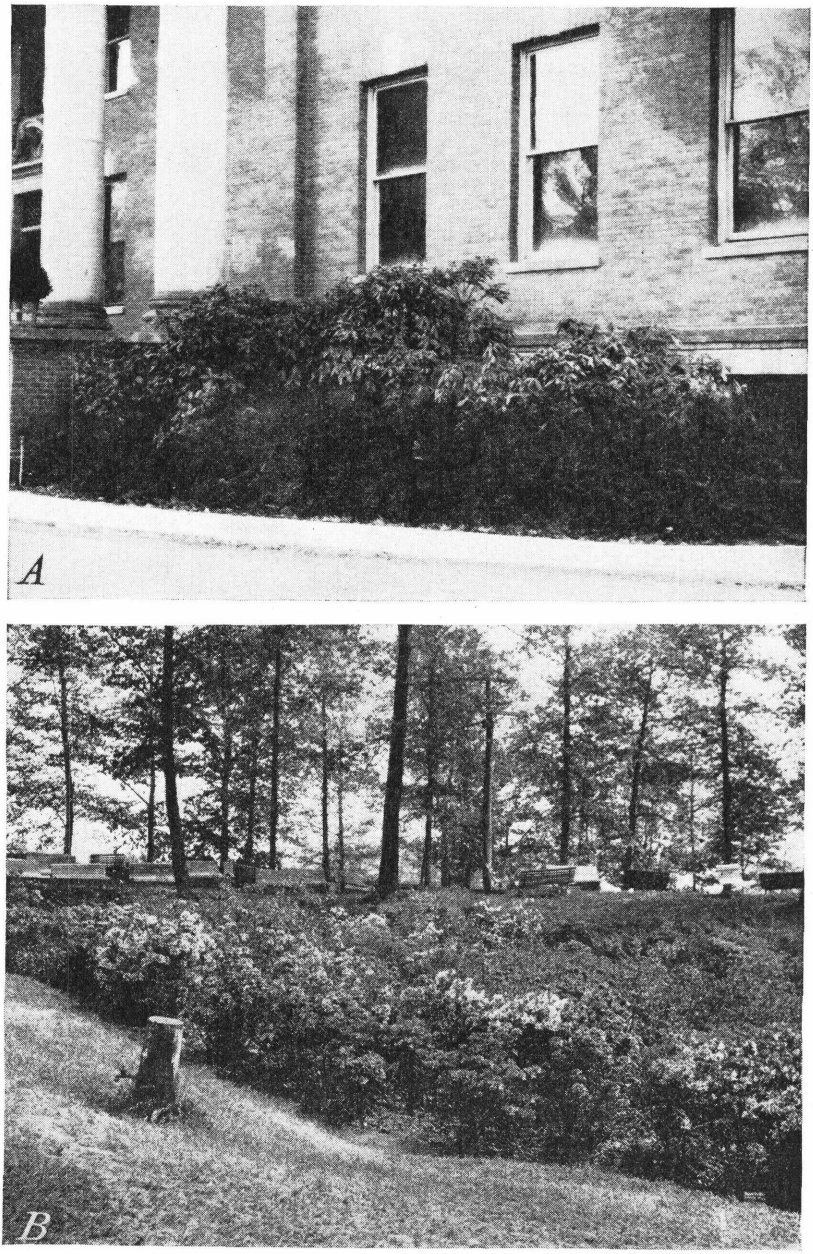

FIGURE 5.—*A*, Plants protected from cold winter winds, but exposed to both direct and strong reflected sunlight, may be injured during cold periods in winter, when unprotected plants would not be; *B*, many plants that have the benefit of some shade in winter are less likely to be injured than those fully exposed to winter sunshine.

growth prematurely. This stimulation makes them more liable to injury from cold than they would be if fully exposed to the cold or partially shaded during the winter (fig. 5, *B*).

Many shrubs grow well in the shade, but most of them do not bloom so freely under such conditions as in full sunshine. Rhododendrons, mountain-laurel, and many similar plants, flower much more freely where they have strong sunshine for at least part of the day than where they are more fully shaded.

Shade and severe root competition combined cause failure where shade alone would provide reasonably satisfactory conditions. The most severe root competition is probably for water and is seen most clearly in the case of gross-feeding, shallow-rooted plants, such as poplars, maples, and dogwood.

TYPES OF SOIL

Plants differ in their adaptability to soils; some grow best in clay, others in sand, others in soils of an intermediate character. A few plants require standing water about their roots, others tolerate it, while still others are killed if it stands about them for only 2 or 3 days; some must have situations above standing water, but grow most luxuriantly if there is a stream or high water table just a little below the level where they are growing, so the roots may readily reach it. On the other hand, there are plants that require dry situations, which means soils well-drained at all times and often bone dry.

Again, plants differ in their response to fertility; some require very rich soils, others are successful only in poor ones. Some plants require soils with an abundance of organic matter; others, soils with little; some require a soil with a decidedly acid reaction, others a soil with an alkaline reaction. Most plants require soils intermediate in many of these particulars, and many thrive under a wide range of conditions. Soils are often modified to better adapt them to special plants it may be desired to grow. They may be made lighter by incorporating sand or ashes, heavier by incorporating clay; excess water may be removed by drainage, and the acidity may be modified by amendments.

GRADING

Soil that has been disturbed by grading is usually left in poor condition for growing plants. Such grading is done by cutting off ridges or cutting into banks and making fills with the excavated material. Neither of the resulting surfaces is suited to the satisfactory growth of plants without special preparation. If the area is to be planted with shrubs, cuts and fills alike should be covered with at least 8 inches of good topsoil; if it is to be a lawn, 6 inches is enough. Topsoil for this purpose should be saved from the surface when the grading is begun (fig. 6), or else it will have to be secured from other land. Soil from land that has been well cultivated or from woodlands that have not been devastated by forest fires is best.

In the eastern part of the country few areas have 6 to 8 inches of topsoil, so that, unless the area graded is small and a large percentage of the land is used for buildings or roads and so does not require covering with good soil, it is necessary to obtain additional soil.

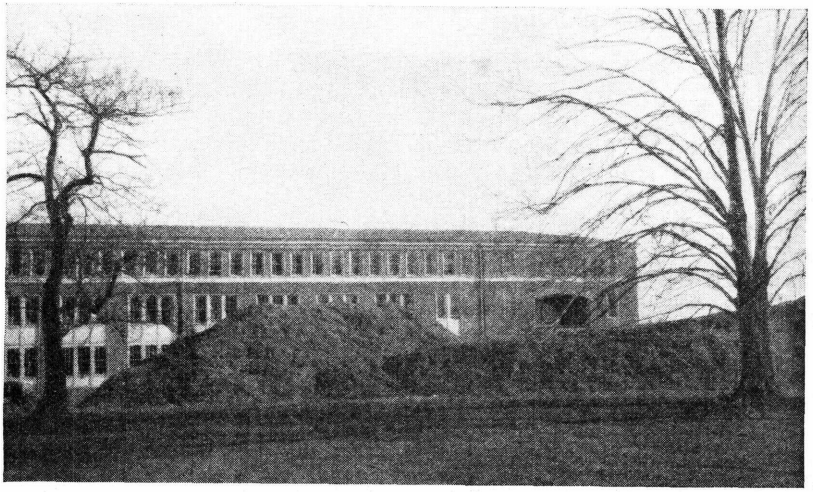

FIGURE 6.—A pile of topsoil removed from land before grading, in order to have it for spreading over the finished grades.

Lack of success in the maintenance of a good appearance with trees and shrubs is often due to failure to supply sufficient topsoil in the original grading. Unsatisfactory results are likely to be more apparent where cuts rather than fills have been made (fig. 7). Where cuts have been made on clay soils it is usually advisable to loosen a

FIGURE 7.—Better results in plant growth are likely to be obtained where the ground has been filled than where it has been cut. These trees are of the same age; those on the left are growing where the ground was cut away; those on the right are in filled ground. The trees in the cut were planted in holes in which 2 cubic yards of good soil had been placed.

foot of the subsoil before applying the topsoil, and still better results are obtained if manure is worked into the subsoil at the same time. Such preparation of the soil simplifies later care, as it usually takes years of treatment with manures, green crops, and fertilizers to transform subsoil into one suitable for nurturing ornamental plants. It can be done, however, by applying a heavy coat of manure, sowing a soil-improvement crop suited to the locality, then plowing under the crop and making a heavy application of fertilizer, more manure, or both, and growing another soil-improvement crop. The soil-improvement crop used will depend on the climate and time of year. This procedure needs to be repeated season after season until proper soil conditions are developed.

FIGURE 8.—A pocket formed by a road fill which could be adequately drained for the support of large existing growth by provision of liberal drainage under the fill opposite the low point.

DRAINAGE

Grading often injures existing trees or shrubs by changing the depth of the water table. Sometimes trees are killed by such a change, either by lowering the water table as little as a foot, by raising it, or even by preventing a rapid run-off of water after a heavy rain. Road and street fills often create pockets where water may stand, whereas the provision of a drain would have saved attractive trees (fig. 8).

SAVING TREES IN FILLS

A tree is likely to be injured if, in grading, more than 3 inches of additional soil is placed over its roots unless there has been erosion; in that case a fill to a depth a little greater than that existing before the erosion began will probably be beneficial. A fill of heavy soil is likely to be more injurious than one of lighter soil. In any filling about a tree not more than an inch or two of soil should be against the trunk, as it may cause the bark to rot and thus girdle and kill the tree.

Sometimes, in grading, it seems necessary to fill around trees it is deemed desirable to save. This is difficult to do successfully, because filling cuts off the air supply from the area of active root action and changes the character of the soil life, thus interfering with the normal functioning of the roots. If the trees are to be saved it is necessary to make sure that air reaches their original feeding ground and to keep the soil from coming in contact with the bark above the old ground level, so that the tree will not be girdled by the rotting of the bark.

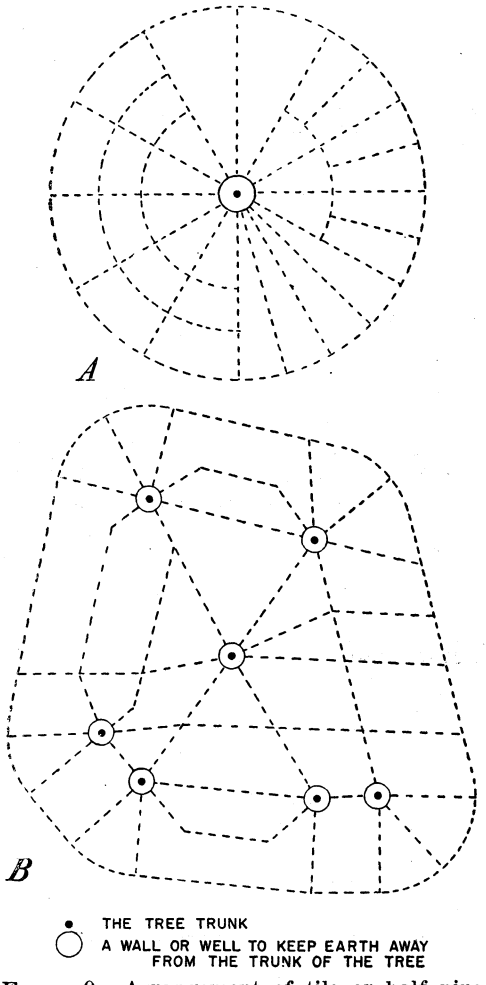

FIGURE 9.—Arrangement of tile or half pipe on the old surface of the ground where fill is to be made, to enable air to reach the original surface and maintain suitable conditions for the continuation of proper soil life for healthy root functioning: *A*, Different arrangements that may be used to insure that a tile is within 3 feet of each point under a tree when it stands alone; *B*, possible arrangement for a group of trees.

One method of supplying air to the soil is to place lines of horseshoe drain tile or split sewer pipe over the old surface. The tile is usually available in the 4-inch size; 6-inch split sewer pipe is the smallest that should be used, but 8-inch would be better, and often the price is but little more. The open side of these pipes should be laid down with the joints just tight enough to keep the earth from working in, and open enough to permit as much air as possible to reach the new fill through the joints, as well as the old surface through the open side of the tile. It is well to cover the joints of the tile with sods, old tin, or building paper, to prevent earth from entering when the tile is covered. The lines of tile or pipe should have the ends joined so that the circulation of air through them will be as free as possible (fig. 9, *A*). No point of the old ground surface should be more than 3 feet from a tile. If the tree is a spreading one the tile should extend to about the ends of the branches; if the tree is of an upright forest type, the tile should

reach half as far beyond the spread of the branches as the distance from the end of the branches to the trunk. The pipe can open into a well, built around the tree (fig. 10, *A*) to keep the soil away from the trunk, or when the fill is on a sidehill the pipe on that side may open where the fill joins the original surface.

FIGURE 10.—Preparation for a fill about a tree: *A*, A protecting wall has been built and a layer of coarse stone placed over the original ground surface; *B*, a layer of fine stone has been placed over the coarse stone, and the pipes for supplying air to the layer of coarse stone are in place.

Vertical tile opening to the air and connecting with the underground system may also be placed at the more distant points to insure freer circulation. Where the attempt is being made to save several trees in a group, lines of tile may be run from one tree well to another (fig. 9, *B*), thus often increasing the freedom with which the air circulates.

Another method of aerating the soil is to place a layer of large stones over the surface of the ground under the tree (fig. 10, *A*), in the case of a spreading tree to the ends of the branches and of an upright tree beyond them. Over these, smaller stones or fine gravel is spread with vertical tile placed at intervals about the tree with the bells up (fig. 10, *B*). These tile with the well about the trunk having wide joints between the stones of the wall permit air to reach the old surface of the soil through the stone layer.

The trees that are most difficult to save when the grade about them is changed are evergreens, beeches, and some of the oaks; those least difficult to save are such as may be propagated more or less readily from cuttings, including poplars, willows, sycamores, and other plane-trees. The tuliptree is more difficult to save under these conditions than the trees just mentioned.

TREATMENT OF FORESTED AREAS

Frequently it is desirable to convert forest areas into parks or home grounds and retain much of the original tree growth without the undergrowth. This is often difficult to accomplish because the radical change of conditions usually accompanying the conversion is injurious to the trees. Substituting lawns for the leaf cover natural to forest areas is especially likely to be injurious. Many feeding roots are in the layer of leafmold that underlies the looser leaf cover and in the upper layers of soil just beneath. Plowing for the lawn destroys these roots.

Grading accompanies such preparation, further disturbing the root systems either by mechanical destruction where cuts are made or by smothering where fills occur. Then the acidity of the soil may be changed, not only by the destruction of leafmold but often by the applications of lime, made for the benefit of a proposed turf but to the detriment of many of the trees. In addition, the destruction of the leafmold permits the drying of the soil to greater depths and this condition is aggravated by the demands of the turf for moisture, so that even more of the feeding roots may be injured. Occasionally such changes result in the death of some of the trees. Maintaining the soil acidity near what it was under forest conditions and supplying moisture in dry times to that level of the soil where the tree roots have not been killed, together with an abundance of plant food, are about as much as can be done to offset the injury due to the changed conditions.

Forests and other natural plant growths are often overcrowded, and thus the tops are not developed as fully as is desired in ornamental plants. If given more room (fig. 11), they will gradually assume a more desirable outline. To develop the tops a clear idea of the ultimate object must be formed and then the removal of undesired plants must begin. Too many trees must not be removed at one time, lest too much sunlight be admitted to trunks that have been accustomed to much shade and the trees desired as permanent ones be injured or killed by scalding. At first the poorest should be taken, but only enough to let a little light onto the trunks of the permanent trees. In a year or two more can be taken out, thus gradually working toward the desired result. Many forest trees are little more than

FIGURE 11.—A gradual thinning of a forest area to permit the development of crowded trees into forms better suited to lawns.

slender shafts with a tuft of foliage at the top, so that the removal of one makes but a slight opening.

In building roads through woodlands only those trees actually in the way of construction should be removed at first; then after the remaining trees are hardened to the increased light others may be removed until all the requirements of the right-of-way are met.

It is often impossible to transform the forest type of tree into the open-field type so much desired as lawn specimens, but the former may be modified by admitting more light to the trunk as just discussed. With more light, small branches and foliage grow much farther down the trunk than under forest conditions and by encouraging this a broader, fuller top can be obtained, though not comparable with trees that have developed in the open. Heading in of the tops is seldom desirable (fig. 12).

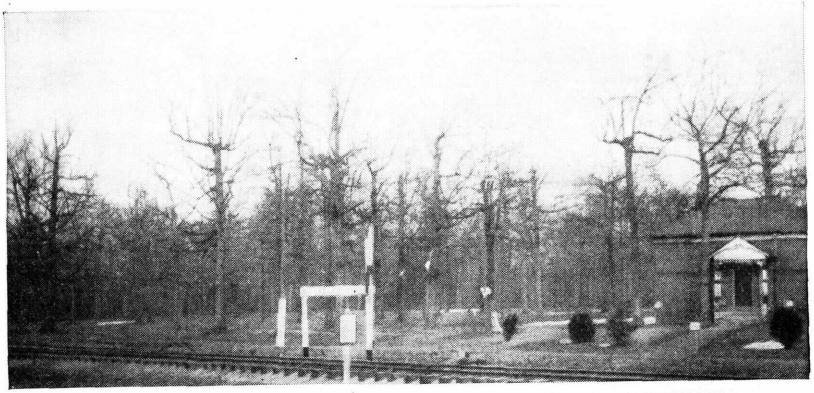

FIGURE 12.—Bad forms resulting from cutting back forest trees.

Woodlands maintained as such for human enjoyment should have as little done to them as is compatible with the use to which they are to be put. This also includes strips of natural growths along public highways. Only as much undergrowth should be removed as actually interferes with the use of the woodland—dead and dying trees and small trees that are completely overtopped by large vigorous ones. Trees showing signs of decline also should be removed. However, if they are not shading young trees, which are developing to take their places, they may be retained until the young trees need the space or there are such signs of decline that they may be regarded as dangerous.

The cover of fallen leaves should be retained, and plantings of low-growing plants should be generally maintained about the borders of the woodland to keep the leaves from blowing away. Fire should be rigorously prevented. Whenever there is a ground cover of dead organic matter, leaves, weeds, or grass clippings, fire is especially injurious. These fires are sometimes set to burn off old grass or weeds, but more often they are started by the carelessness of smokers. Such fires are especially common along highways.

SPACING AND SELECTION

The proximity of plants to one another has a direct bearing on the care they may require. Ample space for both root and top growth in the original plantings gives much better results later than crowding. If the plants are set close at the outset, to obtain immediate results, thinnings must be made promptly when crowding is imminent, so that the form of the permanent plants may not be injured. When plants are set far enough apart so that they may remain permanently with but slight crowding, they may be permitted to do this because it is the group effect, not the individual form, that is sought. If they are too close, the crowding will cause some of the plants to have a pinched, unhealthy look that is hard to overcome without severe thinning.

Sometimes such an unhealthy appearance comes from too severe root competition; for example, if shrubs and trees are growing on the same ground and are all feeding in the same soil layers, that is, all are surface-rooted plants or all are deep-rooted plants. Under such conditions there may not be enough food and moisture for all. Plants that are found wild on moist or almost-wet ground but which also grow on drier ground are usually the worst competitors, as they are likely to have shallow roots and to make heavy demands on the soil for plant food and moisture. To insure success, severe root competition should be avoided either by selecting those plants having roots that feed largely in different soil layers or by supplying an abundance of food and moisture. Plants that are newly set so as to be shaded by those already well established, especially need help the first 2 or 3 years.

CULTURE

The healthy appearance of trees and shrubs that is necessary to contribute the pleasing effect desired can only be assured by continuously providing good conditions for growth.

SOIL PREPARATION

Adequate preparation of the soil previous to planting trees and shrubs reduces the problems of future care. Ample depth of soil on land that has not been graded should be provided, even if the beds for shrubbery groups or holes for trees have to be excavated and refilled. Where the beds are small, a depth of 12 inches is desirable. In towns and cities where the opportunity for root spread is restricted, trees 8 to 10 feet tall should be started with 2 yards of good soil. At least 1 yard of good soil should be allowed in the open country, where there is chance for roots to spread freely. The soil in which the trees are planted should be rich to give them a good start.

Competition for food, water, and sunlight are serious factors in preventing the satisfactory behavior of cultivated plants. If the competition is due to weed growth, the remedy is mulching or tillage. Preventing the growth of weeds requires much more attention in new plantations than in old ones, because in the top growths of newly set plants there is less foliage to discourage weeds. In new plantations, too, the soil has been recently turned and disturbed and thus may have brought buried weed seeds freshly to the surface where they find conditions suited for growth; in older plantations the fight is chiefly with weeds from seeds that have only recently reached the soil without reinforcement from those that may have been buried in previous years. Complete weed eradication each season for a few years, whether in new or old plantations, greatly reduces the amount of weed growth the following years.

The importance of stimulating newly planted trees or shrubs by giving them the best of attention can hardly be overestimated. If an abundance of fertility in the soil is provided before planting, and supplemented by later applications and sufficient water, and relief from weed competition afforded for 2 or preferably 3 years, the future is usually insured without additional special attention. This period is most important, and no more planting should be made in any one season than can be well tended. More care will probably be required the first than the second year, and more the second than the third, as each year's thorough control of weeds reduces the next year's crop and each year there is more shade to help in the control.

Later culture should not be neglected, but in humid climates plantings will be found to require very little care if the work has been well done the first 3 years. In dry regions longer preliminary attention and continual care may be required to offset the effects of drought, especially with plants not fully adapted to the conditions. Plants collected from the wild are more likely to require special attention for a longer time than well-grown nursery ones, if both are handled with the same care.

Whether ornamental plantings on private grounds should be kept free from weeds by clean cultivation or by mulches should be determined by the taste of the owners and the character of the development. On public grounds, especially along roadsides and in parks not in centers of population, mulches are usually preferable, whereas in highly developed gardenlike parks cultivation may be more freely used but should be avoided wherever possible because of expense. Frequently it will be found desirable to employ clean cultivation for a few years and then use a mulch.

TILLED GROUND

Cultivation by stirring the soil around both trees and shrubs is often practiced for keeping down weeds, but beyond weed elimination it seems to have little, if any, value in the stimulation of plant growth. With small and newly planted trees and shrubs, it may be the most convenient way to insure a good start, especially the first 2 or 3 years. Later tillage, in humid climates, particularly with shrubs, may be practiced, because the appearance of stirred soil is preferred to that of a mulch. Continued tillage, after the plantings are fully established, is often warranted in formal plantings and in gardens. However, it is seldom warranted with plantings used for the home setting, on public grounds, even near buildings, or in more remote portions of public parks or along highways.

When ground is kept cleanly cultivated as part of the design, as is done in most formal gardens, the work must be thorough and frequently repeated, which makes it expensive because it is necessary to rework the surface after every rain or watering. When cultivation is chiefly a matter of weed control and not of appearance, the reworking after such wetting does not seem to be so necessary in humid regions, although evaporation is undoubtedly greater from uncultivated ground.

Cultivated areas are spaded each year, thus bringing repeatedly to spade depth mellow soil not occupied by growing roots. This turning keeps large roots from forming in the cultivated upper layer, because each working cuts off any roots that may have penetrated that area, but this cutting leaves a starting point from which new feeding roots enter fresh ground and gather nutriment until the ground is again spaded, only to repeat the cycle.

Deep working to the same depth that has been practiced previously is usually done in the spring; as the season progresses cultivation should be gradually shallower. Such culture each year destroys the feeding roots that formed in the cultivated area the previous year, but does not disturb the carrier roots from which they spring. If, however, cultivation is omitted for a few years these feeding roots grow into carrier roots with feeding roots mainly at their ends, so that deep working of the soil after such an interval destroys many of the main roots as well as the feeding roots at their tips. The resumption of cultivation after such an interval should be avoided whenever possible, but if it must be done extra care is necessary not to prune the roots of the plants too severely. The injurious effects may be partially offset by a correspondingly severe pruning of the top at the same time. When necessary to root-prune a plant severely to permit deep cultivation, spade the soil to the desired depth part way around the plant one year and farther the next, dividing the operation into two or three parts. Each section as root-pruned should be kept cultivated to the desired depth.

MULCHES

After plantings of trees and shrubs are thoroughly established they are more satisfactorily kept free from weeds by a mulch similar to a woodland ground cover (fig. 13) than by cultivation, especially if the plants on the edges of the group have their lower branches

close to the ground so that the leaves that drop remain and decay. A shrubbery group well designed for appearance has plants on the edge with low branches that will hold leaves, and often groups of trees are equally well supplied with low-growing limbs.

Many individual specimens of a spreading, low-branched habit will hold leaves and thus be protected from weed growth in the same way. This includes a large proportion of the shrubs and many trees, including coniferous evergreens, American holly, beeches, and Norway maple when well grown. Leaves in sufficient quantity will develop a mulch worth more to the plants than constant clean cultivation. The combination of mulch and shade from the plants will keep down most weed growth; occasionally a few may need pulling. Such a mulch will provide as good a moisture-retaining cover to the soil as the best of culture, and the decaying

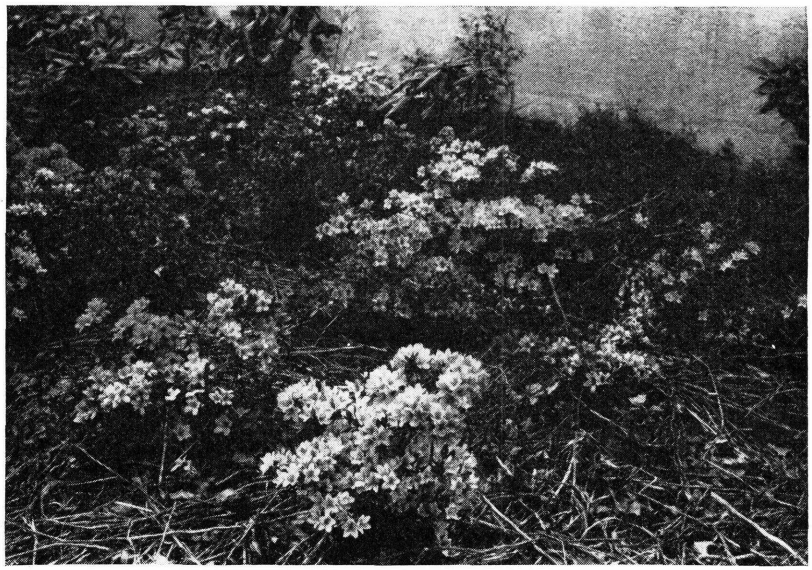

FIGURE 13.—Azalea plants growing with a mulch.

leaves will supply fertility. It is often desirable to supplement leaves that drop from any tree or shrubbery group with others or with other mulching material.

Newly planted trees and shrubs are commonly cultivated for 2 or 3 years after planting, but frequently it is desirable from the start to control weed growth with mulch rather than by stirring the soil.

Mulching is also often effective in preventing the washing of newly planted banks and so may have especial value for roadside plantings in a hilly country; it is usually cheaper than cultivation, though perhaps not quite so good on level ground for many plants the first 2 or 3 years. In such treatment, enough material should be applied to prevent weeds from starting, but the plantings should be frequently inspected to be sure no weeds are growing through the mulch, especially in narrow plantings or those on roadside banks.

Straw, strawy manure, cut cornstalks, leaves, litter, moss peat, and cottonseed hulls are widely useful for this purpose; sawdust, too, is often desirable. Mulching is also most essential for azaleas, rhododendrons, mountain-laurel, and other plants of the same family and is desirable for nearly all evergreens, both broadleaf and coniferous, as well as for deciduous plants. These mulches are best maintained continuously from year to year, the leaf drop of each year being permitted to remain under the plants with material added to help maintain a sufficiently deep cover on the soil. Probably more material should be added in warm humid climates than elsewhere, because such conditions are more conducive to destruction of the cover by decay than are cooler or drier locations.

It is a help to the trees and turf in a lawn area if all the grass clippings are permitted to remain upon the lawn and decay there. Such treatment is as good for the lawn as a heavy dressing of compost each year, and may be done without resulting in an unsightly lawn by having the bottom knife of the lawn mover 2 inches from the ground. With the knives set at this height and the grass cut almost as often as when it is cut very short, the clippings will dry and disappear about the roots, ordinarily within 24 to 36 hours. If because of wet weather or for other reason the grass is permitted to get so long it is not likely to disappear promptly, the lawn mower should be run over the lawn again immediately to stir and recut the clippings.

Grass 2 inches long makes a better turf than shorter grass. It hides the clippings and holds them about the roots, where, by shading, they protect both grass and tree roots from drying out too quickly. It also holds the moisture just as any other mulch would do and keeps the surface cooler. The mulch should not be disturbed when the leaves are cleaned from the lawn in the fall or when the collection of winter debris is removed in the spring.

An iron rake should not be used on the lawn (fig. 14) as it will reach into the grass and remove the decaying grass clippings; a wooden one should be carefully used and so should the fan-shaped bamboo rake that has the ends of the rays turned at right angles to the face of the fan. Above all, the lawn should never be swept with a broom if the health of the trees or turf is important.

WATERING

NEEDS FOR WATER

There are great differences in the needs of various plants for water and their tolerance of its lack or abundance, although all plants require large quantities in their life processes. According to estimates, some plants on a hot day transpire a half pound to a pound of water per hour from each square yard of leaf surface, while a single tree of not unusual size is supposed to use 20,000 gallons in a season.

Great variation is found also in the conditions under which plants can secure the water necessary for their life processes. Some woody plants will grow when surrounded by standing water, whereas others will be killed if water stands about their roots for 2 or 3 days or less; some plants that will grow in standing water will also grow on high ground that is moderately retentive of moisture, for example, taxo-

dium, tupelo, and sweetbay; others will thrive where there is but a small amount of rainfall, as cacti, sagebrush, tamarisks, and eucalypts, and when once established will survive extremely dry times without artificial watering. Because of these differences in behavior, care in selecting plants that are suited to the prevailing conditions as concerns water is as necessary as it is to select them for temperature and sun or shade.

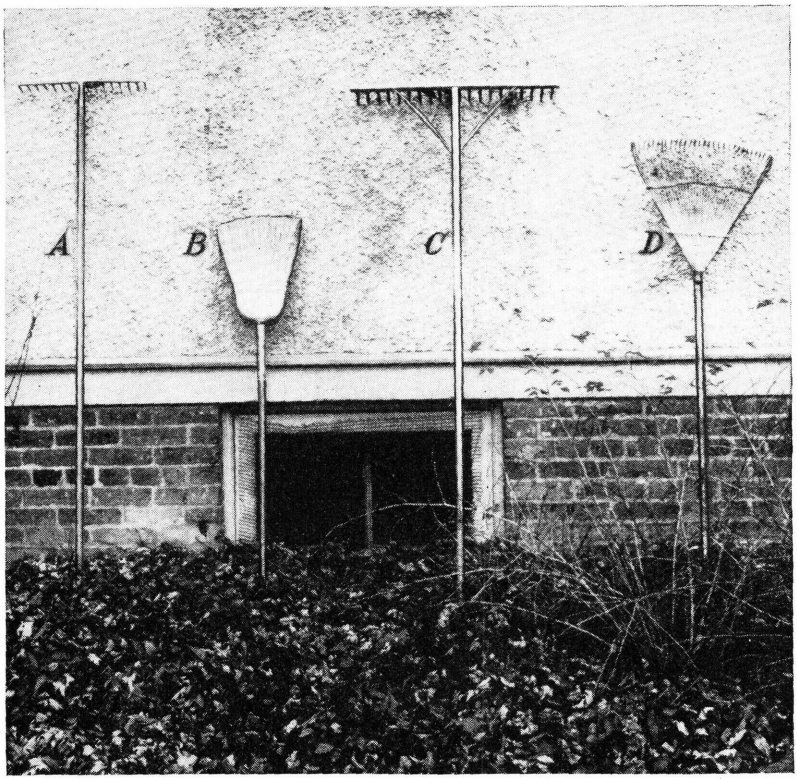

FIGURE 14.—Implements sometimes used on lawns: *A*, A steel rake and *B*, broom, two implements that should never be used on a lawn where trees and shrubs are being grown, as they remove the old grass clippings from about the roots of the turf, thus destroying the mulch and injuring both turf and trees. *C*, A wooden rake with teeth sufficiently close together to be efficient in raking leaves and trash. It must be used carefully so as not to dig into the mulch about the roots of the grass. *D*, A bamboo broom or rake that is also excellent if carefully used, but no pressure should be applied, or this rake will dig out the mulch.

Factors that influence the water available for the use of plants include the amount of rainfall and its distribution; the physical make-up and depth of both surface and subsoil, and its water-holding capacity, which is greatly influenced by the amount of organic matter it contains and the distance to the standing water in the soil, known as the water table. A clay soil will hold more water than a sandy one; conversely, a sandy soil drains more freely than a clay one. A soil with a gravelly or sandy subsoil drains freely and is much less

retentive of moisture than one with a tight clay subsoil. A soil well-supplied with organic matter will hold more moisture in a noninjurious way than one without it and will yield a larger proportion of its water to the use of plants than a soil poorly supplied with it. Fortunately, most soils are composed of mixtures of sand and clay, contain much organic matter, and therefore are adapted to the growth of a long list of plants. Likewise, a majority of species that have ornamental value are suited to a wide range of conditions and will grow on different types of soils with different water-holding powers.

In some soils the water table may be within a foot or so of the surface; for example, in ground that is underlain with an impervious layer of clay; whereas on a gravelly hill the water table may be at such a depth as to be of little benefit to growing plants. The ill effects of too high a water table may be mitigated by artificial drainage of the land, and partial overcoming of too deep a water table may be obtained by keeping an abundance of organic matter on and in the soil and by using plants native to dry countries.

The bad effects of deficient rainfall may be partially offset by using plants from a region where the rainfall is deficient at the same season that it is where they are planted, as they will be inured to such conditions. Deficiencies caused by erratic rainfall or provision for plants requiring more water than is supplied by the usual rainfall of the region where they are planted must be met by artificially providing extra water at timely intervals. This includes watering newly set plants for 2 or 3 years under normal conditions and street trees most of the time after they approach maturity, because of the impervious paving generally used on streets.

APPLICATION

Watering ornamental plants is mostly done by means of a hose even in those regions where fields are irrigated by open ditches. Usually the water is applied too rapidly to be efficient. The amount that can be applied by a person holding a hose usually is inadequate because of his impatience. Water should be applied so slowly that it does not run off and should be continued long enough so that it penetrates at least 5 to 6 inches into the soil for shrubs or trees growing with their branches resting on the ground; but for trees with trunks or with upright branches, especially if growing in turf, enough should be applied to reach the feeding roots. The ideal way is to supply a small amount per minute, continuously for several hours.

Lawn sprinklers with fine sprays (fig. 15) may be obtained that can be attached to the hose to play upon the lawn for several hours at a time, often all day or all night. Such devices can be attached to the hose in series (fig. 16), being placed from 5 to 15 feet apart, as may be found necessary. The more units there are in a series the weaker the pressure at each, thus the shorter the distance the water will be thrown and the closer the units must be placed together. Close placing with low pressure is an advantage for narrow strips. The smaller amount of water supplied per minute by these low-pressure units is often an advantage in large areas and for applying

water under shrubs and low-branched trees rather than over them or through their branches. This is especially true with plants *that* are injured by having drops of water on the foliage in strong sunlight.

The amount of water required to reach the feeding roots can only be determined by digging into the soil 10 or 12 hours after it has been applied and noting the depth to which it has penetrated. Such examinations should be repeated in new locations until it is found how much water should be applied to properly supply the plants. No rule can be given, because each soil is different and the depth of the feeding roots of trees varies. It is safe to say that more water will be required than is usually supposed to be needed, but

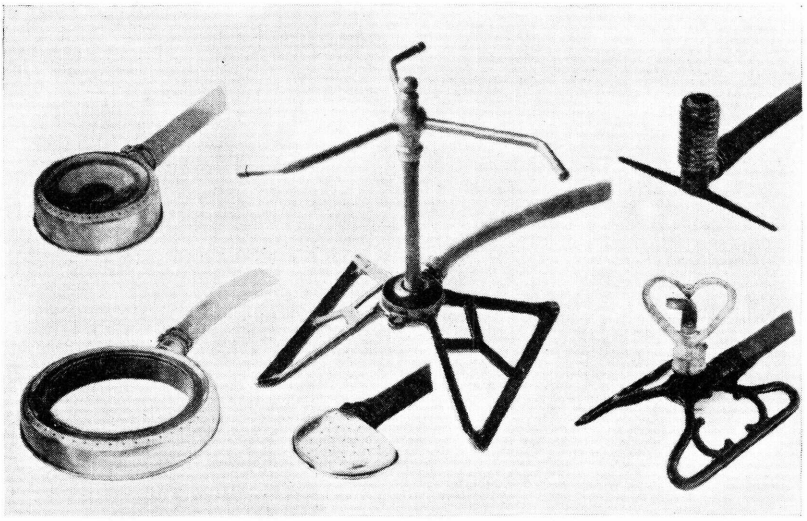

FIGURE 15.—Devices suited to applying water slowly over a long period.

less frequently. Wherever it is practicable water applied artificially should be prevented from evaporating by covering the ground with a mulch either of litter or of earth.

Clay soils should not require rewatering for at least a week, possibly 3 weeks; gravelly soils may possibly need watering twice a week, though soils requiring such frequent watering are unusual in humid regions. Water repeatedly applied in such limited quantity as to soak only to a depth of 2 or 3 inches may be positively injurious, as it has a tendency to stimulate root growth towards the surface, where a few days' unusual drying will kill them. Less frequent but more copious watering stimulates deeper root penetration where the moisture is likely to fluctuate less. Watering plants in groups, whether trees or shrubs, old plantations or new, is usually easier than watering single specimens, especially newly planted ones.

To make sure that the water penetrates deeply about newly planted specimens, earth may be ridged about them to form a basin that will prevent the water from running off before it has an opportunity

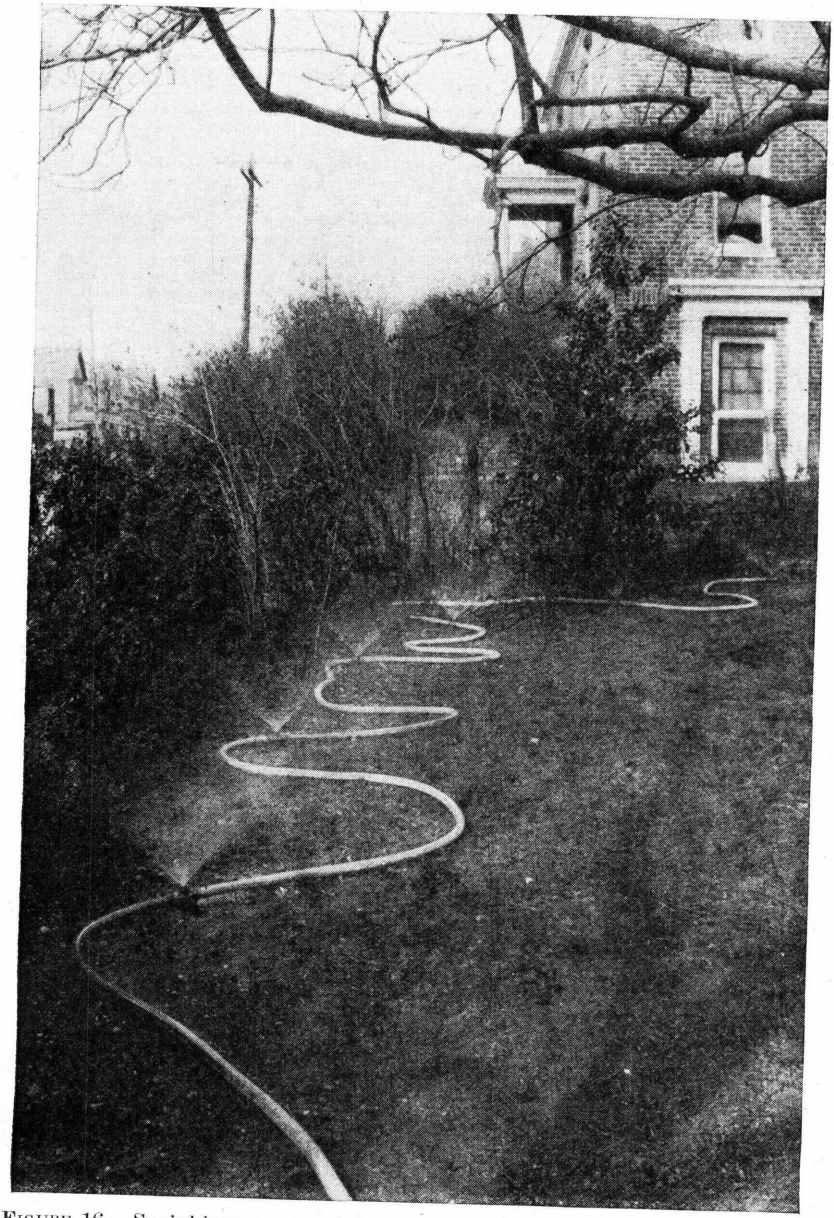

FIGURE 16.—Sprinklers arranged in a series suited for long, slow watering.

to soak into the soil (fig. 17). By refilling such a basin several times, water can be supplied to the depth to which the roots extend.

Trees growing in lawn areas are especially likely to suffer from lack of water. Where this occurs, both trees and turf reflect the need, the turf showing it first and recovering first. Here, again, infrequent drenchings rather than frequent surface waterings give the best results, both for lawns and for trees. They may require special watering to stimulate more vigorous growth, as, for example, in unusually dry weather, in dry regions or newly planted areas, or because insufficient water gets through the turf. The last-named difficulty may be overcome by placing drain tile vertically in the

FIGURE 17.—A basin of earth to hold water about a newly planted tree so that the water may soak deeply into the ground about the roots. The basin should be refilled several times at each watering, to insure deep penetration into the soil.

soil with the top even with or just slightly below the lawn level, so that there is no chance of the lawn mower striking the top of the tile, and the lower end 1 or 2 feet in the ground, depending on the character of the soil and the depth of the tree roots.

Tiles 3 or 4 inches in diameter are usually used although those 2 inches and 5 inches in diameter are sometimes selected, but whether the 2-inch tiles may become clogged to such an extent that they are not thoroughly satisfactory has yet to be fully determined. No large roots should be cut in digging the holes for these tiles. If necessary, in order to avoid roots, the location of the holes should be shifted a little. If the bell end of the tile is put upward it will form a cup into which a block of wood of suitable thickness may

be dropped to come approximately level with the ground and thus prevent any person or animal from stepping into the tile or grass cuttings or trash filling it up. These blocks are easily lifted out when it is desired to put water into the tiles to soak the underlying soil. Sometimes the tiles are filled with coarse stone, which serves the same purpose. They may then be set with the small end up, thus making them less obtrusive. For such tiles, from 10 to 12 feet is probably a good average distance apart, beginning about 7 feet from the trunk of the tree and extending to the end of branches for flat or round-headed trees, and one and one-half times to twice the spread of the branches for upright ones. A more accurate way to determine the area to be watered by tiles would be to dig test holes and find the extent and depth of the feeding roots.

The amount and frequency of watering must be determined by local conditions. A soil with loose gravelly or sandy subsoil will require more frequent light waterings than one with a heavier subsoil. No advantage is gained in putting water below the level where roots are growing. A stiff clay subsoil is nearly always the limit of root extension into the soil.

Another method of tree watering on a lawn is to make crowbar holes 1 to 2 feet deep at frequent intervals over the area to be watered and fill them with water. These holes should not be placed as close to the trunk of the tree as tiles, because of the danger of injuring large roots. It would be well to begin placing the holes halfway between the trunk and the ends of the branches and to continue placing them for a like distance beyond the ends of the branches. The area to be watered could be determined by ascertaining the extent of root spread through test pits. In heavy soils crowbar holes 5 feet apart are usually advisable; in lighter soils they can be farther apart. Such holes should be closed as soon as the ground has dried sufficiently after the watering, and new holes in different locations should be opened for later waterings. A spading fork may be used for opening shallower holes through a turf. These holes need to be closer together than the crowbar holes, but need not be closed after the watering.

In watering a tree provided with tiles, the water should be run in a slow stream directly into the tiles, one at a time, until all have been filled, and the process repeated until the water requirements, as determined by examining the soil halfway between some of the tiles, have been met. Water may be run into crowbar holes in the same way, or the whole surface may be watered if the grass likewise needs attention and enough is applied so that the holes are kept full long enough for the water to spread into the surrounding subsoil in sufficient quantities to help the tree. When holes are made with a spading fork, the surface must be thoroughly drenched to provide sufficient water for the subsoil.

Shrubbery groups seldom need other than a thorough wetting of the surface, whether they are mulched or in clean cultivation, although specimen plants may sometimes need to be watered by one of the subsurface methods. Street trees, and occasionally roadside trees, would be helped by consistent use of the tile method. The same is true of trees growing in much-used sections of public grounds, including parks and playgrounds, where the soil is much trampled.

FERTILIZATION

Under man-made conditions leaves or other organic material are often prevented from collecting and decaying about the roots of plants. When this occurs a substitute must be supplied to keep up soil fertility. Not only do poor soils require the addition of fertilizing materials, but good soils may also need them to promote good growth. Sometimes a fertilizer that contains all the elements of plant food is needed; sometimes only one or two elements are needed.

Fertilizers should be so selected and applied that a steady growth is made throughout a long season, but not so late in the fall that growth does not mature before freezing weather comes. Unripened wood is more likely to be injured by cold than well-ripened wood, and even old wood may be killed by the advent of freezing weather before growth has stopped. Overstimulation of plants and stimulation late in the season may cause growth to continue too long and thus be caught by cold weather.

Late feeding with well-balanced or complete fertilizers probably is safer than feeding with an excess of nitrogen, but even such feedings may be dangerous if they stimulate growth less than 3 months before freezing weather is expected. Overstimulation at any season may cause a vigorous soft growth that is more susceptible than normal growth to the attack of various diseases.

ORGANIC MATTER

Organic matter is an important part of the soil and is more likely to be deficient than are any other of the constituents necessary for plant growth. An abundance of such material tends to facilitate drainage, increase water-holding capacity, improve the tilth of clay soils, and make sandy soils more retentive of moisture. It provides the medium in which the biological life of the soil flourishes. This life has a tendency to destroy the humus that forms from the organic matter, is most active under warm, humid conditions, and so is most destructive in climates providing such conditions. It is difficult to replace humus in soils where organic matter is not frequently spaded or plowed in. On lawns and on land where there are tree and shrubbery plantings such working is impossible.

Heavy mulching, combined with the action of earthworms and burrowing insects that work up and down in the soil, is the nearest possible approach to incorporating organic matter after plantings are once established. Fortunately a mulch usually provides satisfactory conditions for plant growth if it follows the incorporation of an abundance of organic matter in the soil before planting.

The organic matter contained in farmyard manures makes them extremely valuable for fertilizing ornamentals, its value varying both with the kind of manure and the kind of plant as different plants vary in their response to the several manures. Some plants respond satisfactorily to almost any kind of manure; others give more satisfactory results with certain ones; for some purposes fresh manures may be used; for others only composts.

Fresh manure is suitable for many plants, including most vigorous growing deciduous trees and shrubs, such as oaks, maples, lilacs, and crapemyrtles. Cow manure is the least heating of the commoner

manures and is especially valuable for roses, lilacs, and plants that do not respond to heating manures or to an abundance of quickly available nitrogen. It produces its results more uniformly over a longer period than most manures.

Horse manure is probably the most heating of the readily available manures and should not be used about evergreens until it is composted. Sheep, chicken, and rabbit manures are all rich in nitrogen and should be used in moderation, as they may cause extra stimulation and induce soft growth or growth too late in the season. The presence of bedding material, such as straw, leaves, peat, or other absorbent material, is no detriment and often a distinct advantage, especially when it is to be used as a mulch. If the bedding is too coarse it is difficult to incorporate it with the soil when such treatment is desired. Compost is also good for deciduous shrubs, and it is the only manure that should be used about coniferous evergreens, including pines, spruces, junipers, and arborvitae, and broadleaf evergreens, such as evergreen magnolias, camellias, hollies, and rhododendrons. With most of these it should be used only as a mulch and should not be worked into the soil.

Manures containing planer shavings, substances used to prevent breeding of flies, or street sweepings contaminated with automobile oil should be avoided, for all are injurious to most plants.

Green crops turned under are usually a satisfactory substitute for manures as a source of organic matter for the soil, but supplying humus in this way is seldom practicable with land occupied by ornamental trees and shrubs, whether on home grounds, about public buildings, in parks, or along highways. When it is possible to use green crops, the legumes, such as clovers, peas, and vetches, supply nitrogen as well as organic matter, while grasslike crops, such as rye and oats, supply little but the organic matter.

Although manures and green crops are the most satisfactory sources of organic matter, often manure is unavailable and green crops impracticable. Some other organic materials that can be purchased through fertilizer stores and dealers in garden supplies are prepared stockyard sheep and cattle manures; tankage; dried blood; fish scrap; cottonseed meal; soybean meal; ground raw bone and steamed bone; and many brands of moss peat, and humus derived from similar materials.

COMPOSTS

Composts are mixtures of manure and other organic matter which have become sufficiently rotted to break up readily and thus be easily worked into the soil. They are made by piling manure and litter together, after which the mound should be kept sufficiently moist to prevent too rapid fermentation. The mound should be spaded over at intervals of 6 or 8 weeks during the summer, to give all parts an opportunity for the greater decomposition taking place in the middle of the heap. Sods are often added to the pile in layers with the manure to add to its bulk and produce a more friable compost.

A compost pile is made by placing alternately a layer of manure, a layer of sods, and a layer of rich loam, and repeating this process until the pile is as high as can be conveniently handled, usually from 3 to 5 feet. Sods from an old pasture are preferred when they can be ob-

tained. The top layer of the pile should be of soil to catch any ammonia that might otherwise escape. The layers are thoroughly tramped and each one slightly dipped toward the middle, so that all water will soak into the pile instead of running off. Often it is necessary to add water from time to time to stimulate bacterial activity, and when a uniform texture has been produced from the fermentation following the successive turnings the material is ready to use. For use as a top dressing it is not necessary to carry the composting so far as when it is to be worked into the soil.

Often superphosphate or potash salts are put into the compost pile when it is being made or at the final mixing. When the compost is to be used as a top dressing, such supplements can be applied to the plantings separately fully as effectively and often more economically than by placing them in the compost.

Leaves and garden trash of most kinds may also be successfully composted to the advantage of the soil to which they may be applied. Such wastes may be brought into condition for use on the land by piling them with sulfate of ammonia and lime. To prevent the spread of serious disease, affected plants or plant parts should not be composted. Table 1 shows quantities of materials that may be used in such a compost pile.[1]

TABLE 1.—*Quantities of chemicals to use for composting garden litter*

Straw or other refuse	Dimensions of pile 6 feet high	Quantities for pile				Quantities for 6-inch layers			
		Sulfate of ammonia	Lime	Superphosphate	Muriate of potash	Sulfate of ammonia	Lime	Superphosphate	Muriate of potash
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
First formula:									
1 ton	10 by 10 feet	60	60	30	25	5	4⅙	2½	2
½ ton	7 by 7 feet	30	25	15	12½	2½	2	1¼	1
⅙ ton	4 by 4 feet	10	8½	5	4⅙	⅚	⅔	5/12	½
Second formula:									
1 ton	10 by 10 feet	80	60	30		6⅔	5		2½
½ ton	7 by 7 feet	40	30	15		3⅓	2½		1¼
⅙ ton	4 by 4 feet	13⅓	10	5		1⅙	⅚		½

As with manure compost, the pile should be built dish shaped so that all the rainfall will pass into, not off, the heap, and it must be kept sufficiently wet at all times. It is important that each layer be thoroughly trampled, in order to make a compact pile. Where there is insufficient material to make a complete pile at one time, additional layers may be added from time to time (fig. 18). This method is reasonably satisfactory if too much time does not elapse between the beginning of the heap and the addition of the last layer.

PLANT FOODS

Several chemical elements are recognized as essential to plant growth. Of these there is usually enough of each available in average

[1] For further information on utilizing otherwise waste materials, see U. S. Department of Agriculture Miscellaneous Publication 136, Conservation of Fertilizer Materials from Minor Sources.

FIGURE 18.—A compost pile. If soil is placed on top, it helps to retain moisture and hastens decay.

soils for plant growth, except nitrogen, phosphorus, potassium, and sometimes magnesium and lime. It is possible that other elements may also be deficient; for example, one small area in Florida is deficient in manganese.

Of the elements most likely to be lacking, nitrogen is almost always needed, and phosphorus and potassium are somewhat less frequently deficient. Nitrogen is supposed to especially promote growth, phosphorus to insure free blooming, and potassium to intensify colors. A deficiency of any element prevents the others from functioning properly, and the result is unsatisfactory. An excess of one element may make evident the special activity attributed to it.

Among the organic materials that provide nitrogen are animal manures, dried blood, tankage, fish scrap, cottonseed meal, soybean meal, and raw ground bone; inorganic sources are nitrate of soda, sulfate of ammonia, cyanamide, and urea. Organic sources of phosphoric acid are raw ground bone, steamed ground bone, and, in much smaller percentages, fish scrap, tankage, and cottonseed meal; inorganic sources are superphosphate, triple superphosphate, and Ammo-Phos. Potash is chiefly obtained from inorganic sources, such as muriate of potash, sulfate of potash, and kainite—a mixture of potash

salts and impurities as it comes from the mine—and from wood ashes, a material with low potash content, high lime content, and often available locally but not now generally on the market.

COMMERCIAL FERTILIZERS

Best results are obtained by making sure that an abundance of plant food is available. Because organic matter is of first importance, manures should have first consideration, followed by mixed fertilizers, preferably those with an organic base, in order to supply as much organic matter as possible. Such fertilizers have comparatively low analyses, but a low analysis does not of itself mean that the fertilizer is made from organic constituents. A statement to the effect that organic materials are a source of specified parts of the mixture should be a part of the guarantee under which the mixture is purchased.

With every fertilizer offered for sale, a guarantee of its analysis is required. This includes a statement as to the quantity of nitrogen expressed as ammonia (NH_3), as nitrogen (N), the phosphorus in terms of water-free or anhydrous phosphoric acid (P_2O_5), and potassium in terms of potash (K_2O). In most States these are given in the order named, for instance, a 4–8–4 means 4 percent of nitrogen, 8 percent of phosphoric acid, and 4 percent of potash.

Commercial fertilizers range from a total plant-food content of less than 10 percent to over 50 percent. Where a purely inorganic fertilizer is to be applied, it would be economical to use the higher grades, for the proportion of inert material in them is much less, and thus reduce the weight on which freight is to be paid and also the number of bags necessary to hold 100 pounds of plant food. Of course, the richer fertilizers are used in smaller quantities, and more care must be exercised to avoid getting the material on the foliage or in too close contact with the roots. On public works, where laborers instead of gardeners with special training are likely to be employed, manures and organic rather than inorganic fertilizers had best be applied, because there is less danger of injury if these materials are improperly handled. A fertilizer composed of equal parts of nitrogen and potash with twice as much phosphoric acid, as, for example, a 4–8–4 or a 10–20–10, is regarded as good for general purposes and is called a complete fertilizer. This concise statement needs to be carefully scanned, to avoid confusion, as in a few States it indicates phosphoric acid, nitrogen, and potash. Extra nitrogen, which is usually needed, can be supplied in compost or mulch or as a supplementary stimulant.

The quantities of these materials which are desirable or can safely be applied vary greatly. Dried stockyard cattle and sheep manure can be safely and often advantageously applied up to 2 tons per acre or 1 pound for 10 square feet; cottonseed meal, soybean meal, ground bone or bonemeal, up to 1 ton per acre or 1 pound for each 20 square feet; dried blood, tankage, and fish scrap, one-half ton per acre or 1 pound for 40 square feet; a 5–10–5 mixed fertilizer, a 16-percent superphosphate, and other fertilizers of similar grade, 500 pounds per acre or 1 pound for 80 square feet; and concentrated fertilizers, such as triple superphosphate, a 10–20–10 mixture, urea, cyanamide, nitrate of soda, and sulfate of ammonia, 200 pounds per acre or 1

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pound for 200 square feet. Nitrate of soda and sulfate of ammonia being very soluble may often be used more advantageously by applying 50 pounds per acre or 1 pound for each 800 square feet at intervals of a month or 6 weeks.

The quantity of these fertilizers to use per plant can be roughly determined by figuring the area covered by the spread of the branches. Usually shrubs are planted in groups or clumps and trees are in lawns or are with other woody plants, so that the amount needed for the area is much more important than that needed by any one plant. The area to be fed for a specimen tree depends on the character of growth. A spreading tree should be fed to a little beyond the spread of the branches; an oval tree to possibly as much beyond the branches as the area under the tree, whereas columnar trees, such as Lombardy poplar, may need to be fed over an area equal to three or four times the spread of the branches.

On poor soils a wise practice is to apply liberally a well-balanced fertilizer and then if there is doubt as to its proportions for the purpose use a little excess of one of the ingredients on a small portion of the plantation, and the elements usually deficient on other portions, and note the results. It is well to keep in mind the order in which the deficiencies are most likely to occur—nitrogen, phosphoric acid, and potash; and when it is not possible to test for all three elements, begin with nitrogen unless individual or community experience suggests that another element may be the one most needed.

Excepting nitrate of soda and sulfate of ammonia, these materials (p. 31) give best results if applied just before rather than at the close of the dormant season. It is inadvisable to apply them at a time when the soil is likely to remain dry. In dry regions they should not be used at the beginning of the dry season unless irrigation is to follow. They may be worked into the soil or be broadcast on a lawn or a mulch. Because nitrate of soda and sulfate of ammonia are very soluble they are easily leached from the soil. Therefore, they should be used only in small applications on a mulch where their caustic action will hasten the conversion of the mulch into plant food or they should be applied directly to the soil or on a lawn when the roots are active, so that a maximum of the material will be utilized promptly. Both these substances absorb water with great avidity; hence they must not remain in contact with living plant tissues for even a short time, or the tissues will be burned. If these salts are free from lumps they may be sown broadcast on soil that is free from vegetation and either bare or covered with mulch or on soil that is covered with grass or other ground cover if thoroughly wet from recent rains; or they may be sown on turf or other ground cover if the application is immediately followed by a drenching. Perhaps a safer way is to dissolve them at the rate of 1 pound to 10 or 20 gallons of water, following this application with a good watering.

Nitrate of soda usually acts more quickly than sulfate of ammonia and produces an alkaline rather than an acid soil reaction. Sulfate of ammonia is supposed to act over a longer period. Both of these substances are especially valuable for application to plants weakened by transplanting, severe pruning, disease, starvation, or malnutrition.

FERTILIZER APPLICATIONS

The application of fertilizers depends on the kind, condition, and fertility of the soil, the kinds of plants being cultivated, and the methods of culture employed. The feeding of trees, trained with their lower branches resting on the ground, and of shrubs grown in clumps or with their branches similarly growing close to the ground, is usually accomplished by applying the needed materials on the surface under the branches without further attention.

If the soil was reasonably rich before planting and a good mulch has been maintained, little fertilizer is necessary. If the growth is weak when the plants are not overcrowded and have had sufficient moisture, application of fresh manure, compost, stockyard manures, cottonseed meal, soybean meal, or other nitrogenous manures is suggested. They are probably of value approximately in the order named, especially if a mulch has not been well maintained. If there is a good mulch, inorganic fertilizers can be satisfactorily used; even nitrate of soda and sulfate of ammonia may be applied under the branches of such plants without watering, but these substances should be shaken from the foliage if any adheres. Occasionally it may be well to apply a little complete fertilizer to such plantations to be certain that they also have sufficient phosphoric acid and potash. A 5–10–5 mixture could well be used at the rate of 1 pound to 100 to 200 square feet. If especially quick stimulation is desired, nitrate of soda or sulfate of ammonia may be applied, followed immediately by a watering.

Occasionally a shrub is appropriately placed as a specimen away from shrub masses. When it has ascending rather than spreading or drooping branches it is usually difficult to hold a leaf mulch under it, and when it is possible to hold the mulch, the mulch is often unsightly; in such cases cultivation and adequate manuring are the solution of the problem. Sometimes a winter mulch of coarse manure that can be worked into the soil or removed in the spring may be applied, but when the growth of the plant hides it, the mulch may remain on the soil from year to year.

Shrubs and trees growing in lawns need to be supplied with an abundance of plant food. Often they can be adequately nourished by liberally feeding the lawn. A well-fed lawn receiving copious and timely waterings in times of drought is usually able to support good tree growth as well. More plant food than the turf requires must be supplied, however, so that some will get past the grass roots to the tree roots. The best fertilizers for this double purpose are well-composted stable manure applied at the rate of 50 to 100 pounds per 100 square feet, prepared stockyard manures at a rate of 10 to 25 pounds per 100 square feet, or ground bone or cottonseed meal at a rate of 5 to 10 pounds per 100 square feet, applied in the fall or spring but preferably in the fall. As a summer stimulant, nitrate of soda or sulfate of ammonia may be used at a rate of 1 pound for 800 square feet of lawn at intervals of a month or 6 weeks up to midsummer, or in the frostless regions practically all the year.

Another method of stimulation is to make holes with a crowbar or post-hole digger, as discussed under Watering, and pour into these holes manure leachings or fill them with pulverized manure, nitrate

of soda, sulfate of ammonia, or other fertilizer high in soluble fertility, and flood each with water. If tiles are used for watering (p. 26), strained manure leachings, nitrate of soda, and sulfate of ammonia could be placed in them and watered into the soil; it would not be suitable to place materials that are not entirely soluble in these tiles because of clogging them, thus making them ineffectual for their main purpose. A special type of air gun is sometimes used for loosening the subsoil by air pressure. Readily available fertilizers may be blown into the soil with the aid of such an implement, either by placing the material in holes made by the gun and again blowing, or by feeding the fertilizer into the air stream by a suitable attachment. To what extent and under what conditions such loosening of the soil is beneficial has yet to be determined, though in the hands of expert operators it apparently gives satisfactory results. Many firms expert in tree pruning are also prepared to handle the more intricate tree-feeding problems.

Occasionally, even the above methods of feeding trees in lawn areas do not seem to supply all the needed nutriments. This may be because of an alkaline soil reaction when the tree naturally grows in an acid soil or vice versa, as discussed later. It may, however, be because insufficient plant food gets to the tree roots. A more drastic method of supplying this lack is to dig a trench about the tree a little beyond the spread of the branches. The depth of the trench should be a trifle greater than that at which the roots are found. This trench is at once refilled with well-enriched earth to provide a rich feeding ground for the new roots that will be formed at the cut ends made by digging the trench.

A still more extreme method of treating trees in lawn areas is to give the lawn a heavy application of manure and fertilizers and plow it in, the depth of the plowing depending on that at which the tree roots are found. Too many roots should not be destroyed, although many will necessarily be exposed if the lawn is an old one. In addition to destroying tree roots another disadvantage is that turf plants deeply rooted in the soil will also be destroyed, and usually it will take from 3 to 5 years to get the new grass plants sufficiently deeply rooted to make another good lawn. When such extreme measures are taken, it is generally advisable to devote at least a year to soil-improvement crops and additional applications of manure and fertilizer before again reseeding. This would mean at least three plowings and the incorporation of much organic matter and other needed plant food in the soil, which would benefit both trees and lawn.

SOIL ACIDITY

Besides differing in fertility and water-holding capacity, soils differ in acidity; some are neutral, some acid, and still others are alkaline. Both acid and alkaline soils differ greatly in the amount of their acidity or alkalinity, many of them being only slightly removed from neutral and others being more acid or more alkaline. Some soils are so acid that only a few kinds of plants will grow on them, whereas the most alkaline soils in the United States are not so markedly alkaline. So-called alkali lands are not unproductive be-

cause of extreme alkalinity, but because they are saline—that is, impregnated with injurious salts.

Plants differ in their response to soil acidity, and this is as much a factor in determining what plants may be cultivated in any location as the temperature, water-holding capacity, and fertility of the soil. A large proportion of plants thrive on soils that are either acid or alkaline though not far from neutral. Some thrive in markedly acid soils but will tolerate only a little alkalinity; others are the reverse, standing only a little acidity, but growing luxuriantly where there is strong alkalinity. There are plants that will grow only in alkaline soils and others only in acid soils; one group thrives only in strongly acid soils; some plants thrive under a wide range of acidity or alkalinity, others only under a narrow range. These extremes may or may not include the neutral point.

The plants cultivated in central Europe a century ago, both in the fields and in the vegetable and flower gardens, were from a soil near the neutral point, possibly most of them preferring soil slightly acid to one that is alkaline. These are the plants about which our colonial farming and gardening were developed and to which the rule-of-thumb methods that have come to us from Europe apply. Other plants were not readily cultivated, but recent discoveries regarding the acid reactions of soils have explained some plant behaviors not previously understood and have broadened the knowledge of plant requirements and increased the number that can be successfully cultivated.

Several methods of determining the amount of soil acidity have been developed, the most accurate being the electrometric method, in which a hydrogen electrode is used in soil suspensions. In other methods the color change produced in selected dyes by different degrees of acidity is used. Although these latter methods may not be as accurate as the former, they are usually more easily handled, and many of them are accurate enough for practical purposes.

Relative degrees of acidity are expressed by pH numbers. The number indicating neutrality is 7; those indicating alkalinity are above this, and those denoting acidity are below it.

In the eastern part of the United States soils in general are acid, but they vary widely from a pH reading of 4 about sphagnum bogs and 5 in some unlimed cultivated lands to 6 and more in limed soils. The soils of the Great Plains near the Rocky Mountains are usually alkaline with a pH reading of about 8; they become neutral east of the Missouri River, and acid as the Mississippi is reached. Soils in the Rocky Mountains vary much even in short distances, though they are preponderantly alkaline; the soils west of the crests of the Cascade Mountains and the Sierra Nevadas are mostly acid.

The acidity of soil may be changed for the benefit of plants requiring it. Lime is the age-old amendment for making acid soils alkaline. Hydrated lime, finely ground limestone, and wood ashes are used in quantities less than sufficient to neutralize the soil acidity. Where soil tests indicate that 8 tons or more of lime per acre would be required to neutralize the soil, often only 1 ton or even one-half ton per acre or 1 pound to 20 or 40 square feet is used, and with a variety of field crops this seems to be producing satisfactory results.

Among plants especially adapted to alkaline soils, though also thriving in acid ones, are honeysuckles (not the miscalled wild honeysuckle, which is an azalea), tamarisks, oleasters, snowberry, coralberry, and lilacs.

Likewise there are means of making soils more acid, as required for the culture of blueberries and a number of ornamentals, such as rhododendrons, azaleas, laurel, camellias, and gardenias. This can be done by using aluminum sulfate up to as much as 1 pound for 20 square feet of area. However, for most plants requiring acid soils it is better to provide the acidity with a mulch that will tend to create the needed acid and other conditions conducive to successful plant growth. In order to produce the desired effects these mulches must be permitted to remain about the plants and rot, as acidity is not produced from most of them until they are partially decayed, their effectiveness beginning about the second year.

Reasonable applications are oak leaves about 12 inches deep, pine chaff (needles from pines and other coniferous trees) 5 to 6 inches, sawdust (preferably that which has weathered for a year or two) permanently maintained at a depth of 2 inches, and acid moss peat from 1 to 2 inches. Even twigs pruned from woody plants soon decay sufficiently to be used as a mulch. These materials are best applied in the fall so the rains and snows will pack the mulch, thus sooner promoting decay. It is often desirable to use aluminum sulfate as a special acidifier immediately after planting before the mulches have had an opportunity to decay sufficiently to produce the desired acid conditions or if for any reason the mulch is deficient in quantity or acidity or has been disturbed. Cultivation not only prevents the development of the acid soil required by these plants but also injures or destroys the roots that develop in the rotting layers of mulch. From year to year an undisturbed mulch should be maintained, upon which the new material should be placed each fall. Lime or wood ashes should not be applied directly or to land the wash from which may run where acid-loving plants are being grown, as it is likely to be injurious or fatal.

Some plants require decidedly acid conditions, as rhododendrons, azaleas, mountain-laurel, camellias, and many nearly related plants; many others, such as magnolias, hollies, most of the coniferous evergreens, and many oaks, require less acid conditions.

PRUNING

There are three reasons for pruning ornamental woody plants: To promote vigor and healthfulness, to control form, and to modify their flowering.

The accomplishment of these ends requires much less pruning than is usually supposed. No pruning should be undertaken without a careful analysis of the purpose for which it is to be done; otherwise more harm than good is likely to result. It is better not to prune at all than to prune without a clear idea of the results to be attained. There is a great tendency to prune without such clear conception of a specific need for it, especially in late winter and early spring before the ground is sufficiently dry to provide an abundance of other work. Severe

cutting is seldom required, but plants should be inspected at rather frequent intervals to make sure that whatever is required may be *done* at the proper time.

PRUNING FOR VIGOR AND HEALTHFULNESS

Pruning for vigor and healthfulness consists in the removal of dead or dying wood and broken or split limbs, cutting off stubs that have resulted either from the breaking of limbs or from improperly made cuts in previous prunings, removal of crossing and interfering branches, and reducing the top to offset root injury due to transplanting or other causes.

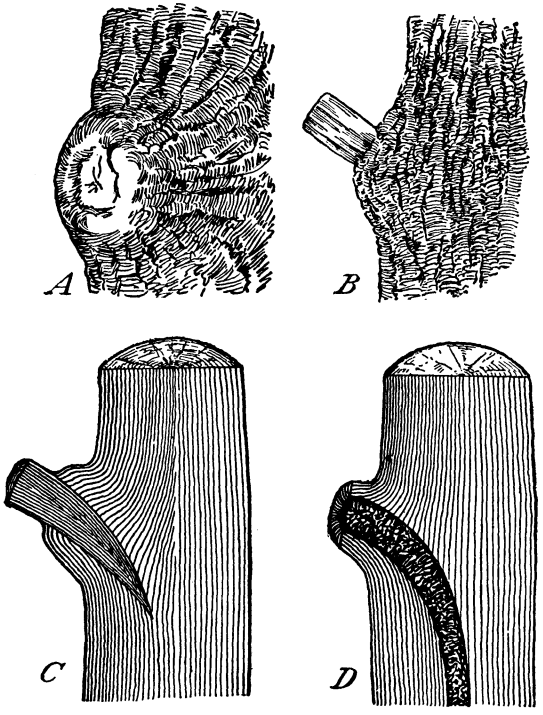

FIGURE 19.—*A*, Cut made close to trunk and followed by prompt healing; *B*, cut made too far from trunk, precluding healing; *C*, stub resulting from incorrect pruning shown in *B*; *D*, decay following nonremoval of stub.

Dead, dying, and broken branches should always be removed, the sooner after they become defective the better. Their removal improves the appearance of the plant and, with trees, reduces the danger from falling branches, especially along highways and in other frequented areas. Such treatment also makes possible the early healing of the wound, thus reducing the danger that injurious decay organisms may enter. In removing dead branches from trees, the best method is to cut back to the nearest living crotch, or with shrubs even to the root, though it takes off live wood. Stubs, too, should be promptly removed (fig. 19), as open wounds facilitate access of injurious decay organisms, and stubs retard proper healing.

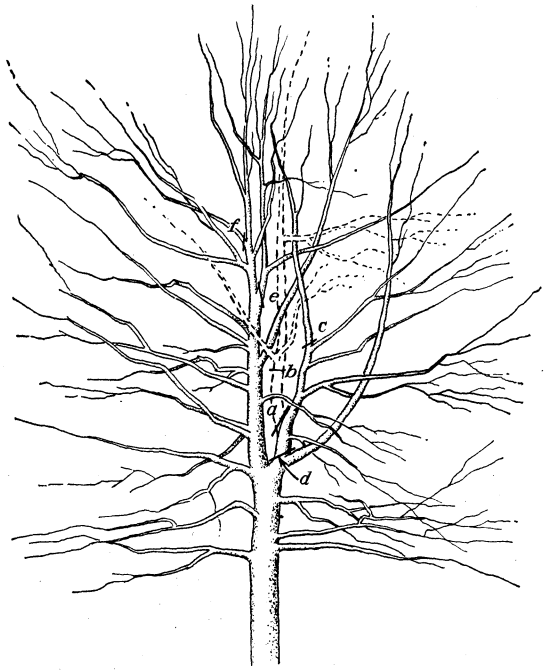

FIGURE 20.—This tree has objectionable upright shoots too nearly paralleling the leader. The largest secondary shoot should be removed at *a*. A cut at *b* would leave a bad stub that would be slow in healing and might never heal. The smaller shoot should be cut at *c*, and as the growth of the remaining portions of the tree fills the opening that is left, other portions of this branch might be removed at the lower crotches until possibly all are removed by cutting at *d*. The new growth may be at such points that a better shaped tree will result by making cuts only at *a* and *c*. Cuts may be desirable at *e* and *f* either now or later.

A branch that is growing across the center of the plant or crosses nearby limbs should be removed while still young. Usually such a branch can be detected while small enough to be removed by a knife. As the plant grows and the limbs get larger, crossing branches eventually rub one another, making abrasions that may become infection points for organisms that cause decay or other injury. Occasionally this rubbing so wears the limbs that they become weakened and are liable to break. However, the most important reason for this pruning is that a more attractively formed plant results if the branches radiate more or less directly from a point or a common axis.

Two branches growing close together, almost parallel, and separating from a common support by a very small angle are also to be discouraged by shortening or removing one of them (fig. 20), because a crotch formed in this way is more likely to split than where three or four branches separate from practically the same point, or two separate at a wide angle. Narrow crotches are especially undesirable when the branches are growing upright; if such shoots start near the ground in a young tree and develop unchecked, double trunks may result. The objection to such growth is the possibility of the crotch splitting

under the strain. Stems growing close together crowd one another so that each develops its growth mainly on one side. This combines a weak form of crotch with a one-sided top, which may succumb to strong winds or heavy snows. Sometimes parallel branches grow several years before their undesirability is recognized.

When such leaders are developing, the one with branches best distributed should be selected for retention, while as much of the other should be removed as is possible without leaving too much of a gap (fig. 21).

The objectionable leader may be removed a little at a time (fig. 20) until as much as can be spared has been cut. This usually results in a conspicuous bare space which will soon be filled in. After this, side branches should be removed from the remaining portion of the leader to reduce its importance further and to permit the thickening up of the branches on the main one, so that eventually more of the discarded leader may be removed. If the upright growth is checked, however, the side growths that may develop from the remaining lower portion are seldom objectionable.

Vigor of plants is often promoted by reducing the amount of top to more nearly equal the ability of the roots to supply plant food, especially moisture. Usually this should be done with newly planted

FIGURE 21.—*A*, Tree with extra leaders developing; *B*, the same tree with extra leaders removed, producing a temporary opening through the bottom of the tree.

trees and shrubs and may prove beneficial with plants that are not growing as freely as they should, although provided with sufficient food and moisture.

Precautionary pruning to maintain a balance between top and roots should be done whenever there has been any considerable mutilation or other disturbance of the root system. This is especially necessary with plants that have been dug from the wild, as three-fourths or more of the roots of such plants are usually left behind. Pruning should be carefully done to maintain as nearly as possible the natural form of the tree by thinning out whole branches rather than shortening their ends (fig. 22).

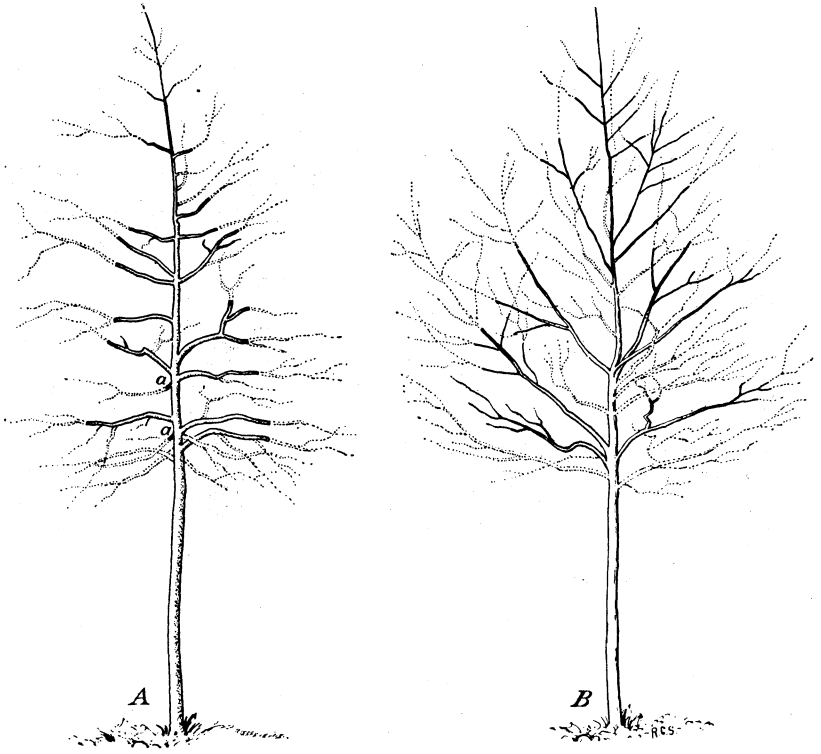

FIGURE 22.—Trees trimmed to maintain the natural outline as nearly as possible when severe pruning is required because of transplanting or root destruction from other causes. *A*, Pin oak. Note the bad stubs (*a*, *a*) on the left-hand side of the tree. *B*, Sycamore well pruned, without bad stubs. When branches are headed in, they should be cut back to a bud.

Pruning to promote vigor should not be made an excuse for pruning severely where lack of vigor is not markedly evident or root destruction is not strongly suspected. There is much tendency to prune both shrubs and trees for the mere sake of pruning; many are severely injured or ruined by such treatment (fig. 23). When done as a remedial effort for established trees, there is always a possibility that the tree may never sufficiently recover from the severe treatment to be regarded as normal.

Where illuminating gas, salt water from ice-cream cans or other sources, calcium chloride, which is frequently used to melt snow or lay dust, or other materials have polluted the soil, it may be desirable to prune the plant severely at once in order to reduce the demands of the top for moisture. This might lessen the amount of toxic material that is taken into the plant with the water before the poison is removed from the soil. Illuminating gas escapes to the air, and this may be hastened by digging holes to serve as vents or by forcing compressed air into the soil with the air gun mentioned earlier, or both. Salt and similar substances may sometimes be washed out of well-drained soils by a heavy watering.

Cavities are often found in trees, especially where care has not been consistently given to keep them in good condition.[2] In general, the treatment consists of removing all traces of rotten wood and coating exposed surfaces with antiseptic and wood-preserving substances, and

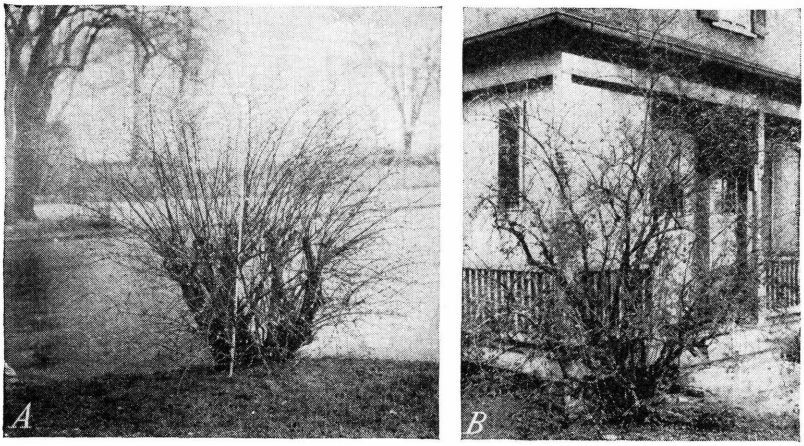

FIGURE 23.—Bush-honeysuckle. *A*, Badly pruned, the natural form of the bush having been completely destroyed. There is little chance of developing a new top without ugly stubs. *B*, Well-pruned. This plant seldom requires pruning because of its habit of growth.

sometimes even with a penetrating disinfectant. Cavities must not hold water and must be kept thoroughly protected with wood-preserving substances. For the sake of appearance, it may be desirable occasionally to fill them with sawdust and asphalt, tarred or asphalted wooden blocks, or concrete.

PRUNING FOR FORM

Pruning for form includes the slight pruning usually required by plants in informal plantings to maintain their natural outline and the frequent severe pruning and even shearing to adapt plants to formal design (fig. 24), of which the pruning of hedges is one of the common examples. In pruning to improve appearance in naturalistic designs, it should be kept constantly in mind that the natural form of the plant is the most attractive. Often a plant needs a little help to as-

[2] Detailed information for the handling of tree wounds and cavities is found in Farmers' Bulletin 1726, Treatment and Cure of Tree Wounds.

sume this characteristic shape; sometimes it is the removal of branches that are running wild and deforming it that is needed, or sometimes a thinning to reduce the number of branches, as is occasionally done with Norway maples. An attempt to re-form a plant that is not of the right size or shape to fit its surroundings is seldom satisfactory (fig. 25), as a monstrosity usually results. It is much better to remove such a misfit and substitute a plant appropriate for the location.

If a tree grows more vigorously on one side than on the other, some of the surplus growth should be removed by cutting off branches at a crotch (p. 37). Branches that are likely to interfere with traffic or are otherwise in the way should be removed promptly. The limited amount of pruning usually necessary for this purpose is not likely to prove injurious at any season of the year.

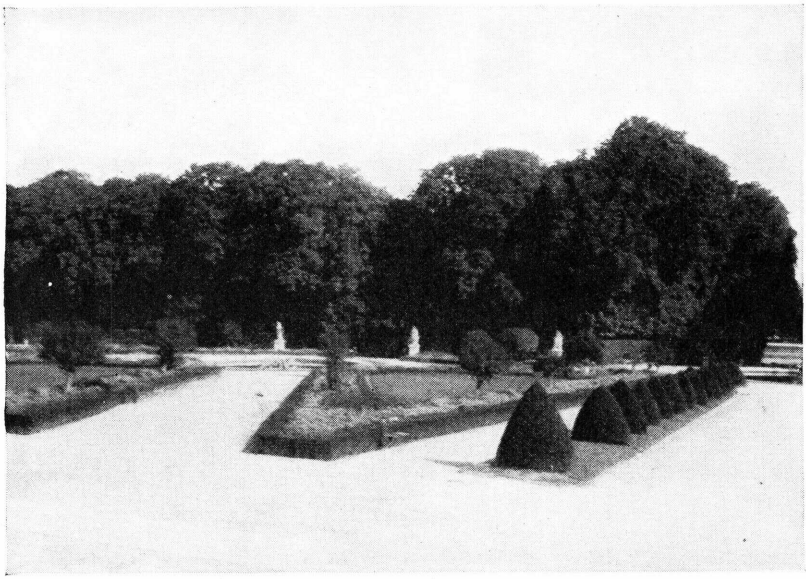

FIGURE 24.—Formally trimmed plants in the foreground.

Trees pruned at transplanting often present a problem later when pruning for form. This is especially true of rapidly growing trees, such as poplars and some of the maples under favorable growth conditions. It is a common practice to cut one-half or two-thirds of the growth from young trees; this induces branching just below the cut, but stimulates an undesirable vigor that again invites the pruning shears the following season, each successive year creating a more unfavorable situation. Probably the condition is most satisfactorily met by clipping off the tips of the shoots in the growing season whenever enough growth without lateral branches has been made (fig. 26). If three or four shoots grow from below the cut, the head can be developed satisfactorily; if only one shoot starts or one of the shoots is much stronger than the others this again should be checked by cutting off the growing tip. The aim should be to stimulate growth in many branches rather than in a few vigorous ones that become unduly long.

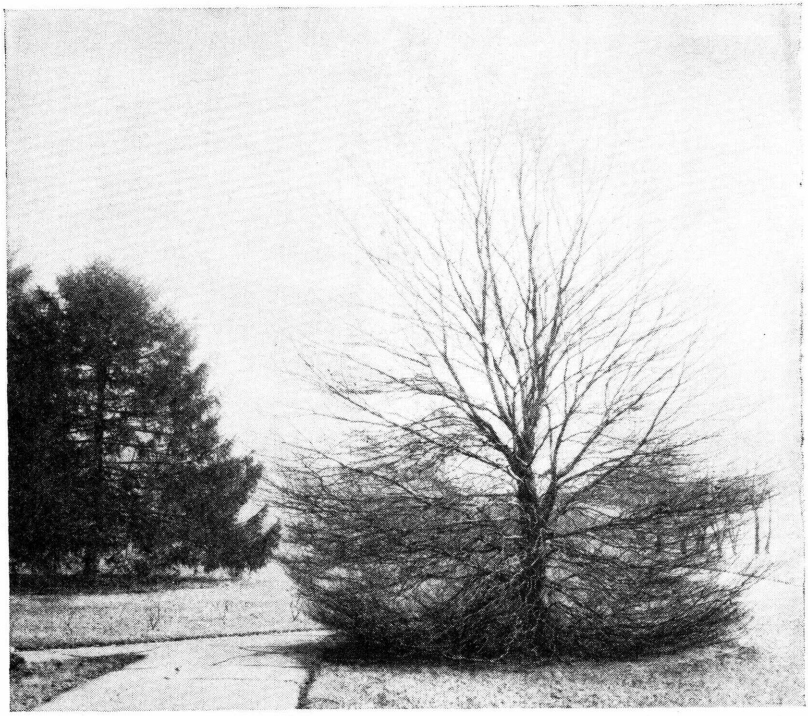

FIGURE 25.—A spruce and a beech growing in their natural forms, with their branches close to or on the ground.

FIGURE 26.—Carolina poplar trees that have been severely cut back, resulting in long young growths that in the middle of the growing season need a foot or so removed to induce secondary branching.

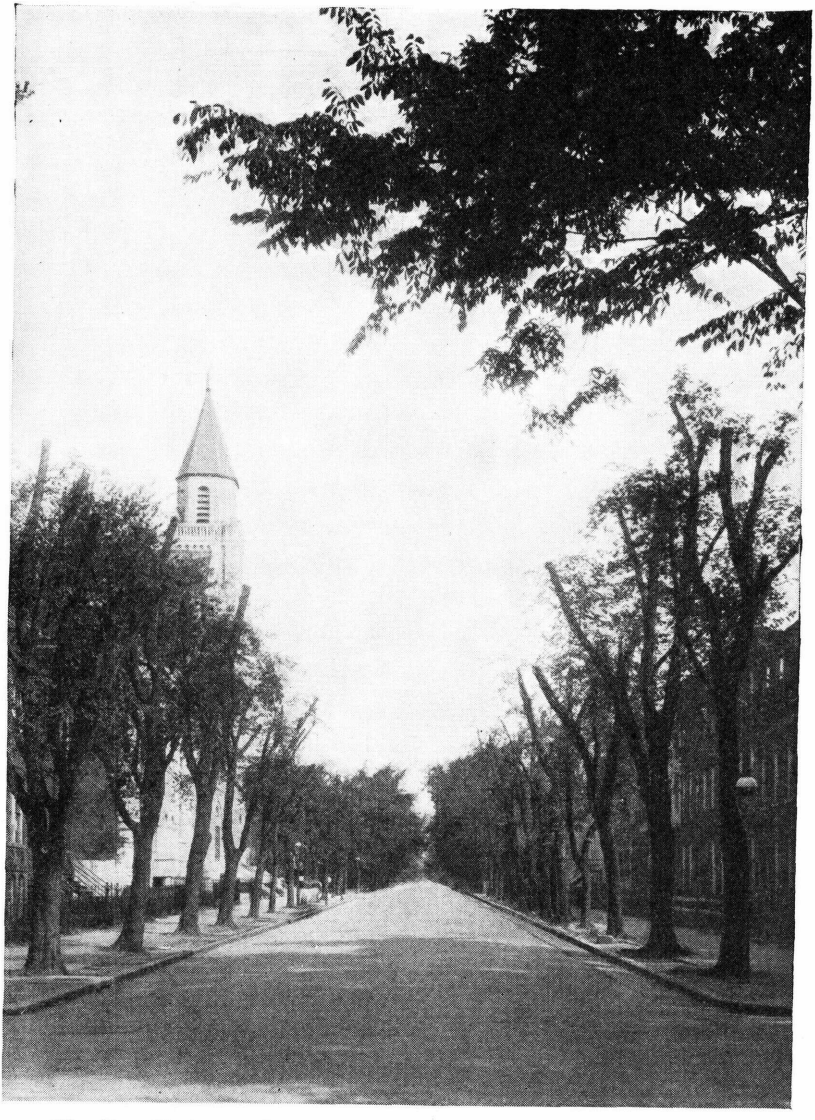

FIGURE 27.—Tree limbs of silver maples, 2 inches or more in diameter, cut straight across instead of parallel with the remaining branches, leaving stubs that seldom heal and giving the tree an unattractive form.

Another problem in pruning presents itself when a tree overgrows the space available for it. Reducing the size of such a tree may seriously endanger its health, but if the end justifies taking a chance, prune. Such treatment is especially serious with silver maples (fig. 27).

Decay organisms are likely to enter the cut ends of such stubs even when they are painted, and once started the organisms usually follow down the inside of the branches into the trunk (fig. 19, *D*). New

FIGURE 28.—Pruned sycamores: *A*, As they appear in summer; *B*, as they appear in winter with bunches of shoots from the old cuts instead of the graceful branching natural to these trees.

lateral branches from buds near the end of a limb develop in clusters, producing an unsightly appearance, and it is extremely difficult to thin them out satisfactorily.

Trees trimmed in the manner described may make a compact mass of foliage in summer, but the winter appearance is unattractive because of the bunches of new shoots (fig. 28).

When plants are set too close together it is sometimes desirable to remove some of them, leaving as small a gap in the foliage masses as possible. This is frequently necessary in parks, on streets, or in other public places, to prevent, as far as possible, adverse criticism raised because of the removal of plants from public grounds, even malformed or unhealthy ones. The removal can often be unobtrusively accomplished by selecting those trees or shrubs to be kept, then pruning severely every part of those to be removed that may interfere with the development of the plants that are to remain. When the undesired plant is so reduced by repeated prunings that there is but little of it left and the permanent plants have grown to fill the space, the removal of what is left will leave such a small opening it will scarcely be noticed.

Tree rows may also be thus thinned. This method may be used in establishing better conditions for overcrowding highway trees. Alternate trees may be trimmed in the course of a few years so that they constitute a mere fan between the permanent ones and when removed leave but a very small opening. Occasionally two trees need to be removed between the permanent ones. This is more difficult, but by keeping the condemned trees until one side has been entirely removed, the best that is possible has been done. When the time for removal comes it must be determined whether it is best to remove both trees the same year or in succeeding years. The former method results in the larger gap, the latter in a more ragged appearance.

Evergreens in informal plantings often need slight pruning to maintain their natural outline under artificial conditions. Sometimes, too, these plants become scraggly and open in growth, though when young they may have presented a compact appearance. This scraggly appearance may be overcome or even prevented by pruning the longer branches back at suitable forks a short distance inside the crown (fig. 29). By this means the most rapidly growing shoots will be checked, and the remaining limbs will branch and make the plant more dense. Even spruces and firs may be checked in this way and develop a more compact growth. The central upright shoot (fig. 30) must never be removed if it is desired that the tree shall grow taller and maintain its symmetrical form.

If a leader has been destroyed, a new one may be developed by fastening securely to the main axis of the tree a light but strong supporting pole extending a foot or 15 inches above the point where the new leader is needed; then from the branches at the base of the destroyed leader select the strongest one that is well placed and tie it securely to the pole in as nearly a vertical position as possible. This should eventually become set in this position and will become the main axis of the tree.

Occasionally young trees are crooked or have crooked branches where it is desired they should be straight. Often these may be straightened

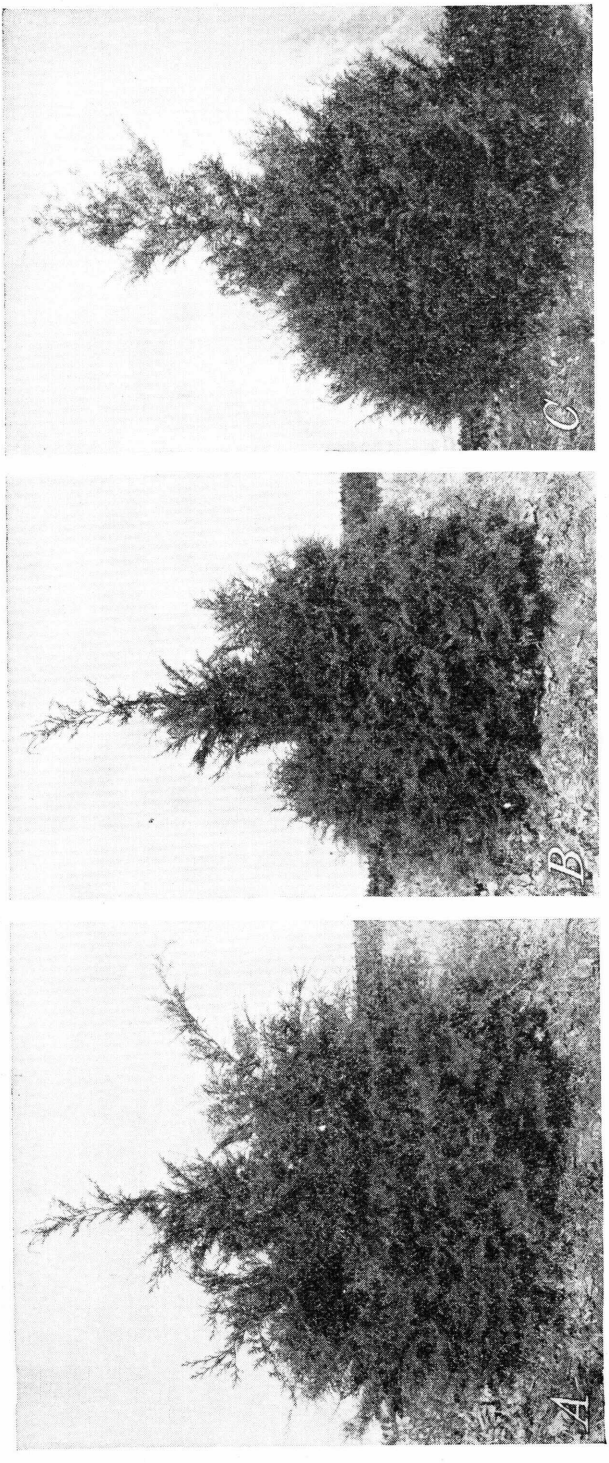

FIGURE 29.—Pruning a Japanese cypress: *A*, Before pruning; *B*, after pruning; *C*, 1 year later.

FIGURE 30.—A leader (*a*) is necessary for this type of plant if the upright symmetrical growth of this spruce is to continue.

by being tied to some substantial support near the position that it is desired they shall assume. It is not possible to modify large branches in this way. Where a tree is leaning, it is sometimes possible to dig about it and reset it in an upright position. This means practically replanting so far as its effects on the tree are concerned.

Evergreens growing too large for the space allotted to them may often be kept within temporary bounds by removing the leaders and heading back the side branches to the nearest crotch. If persistently followed, this treatment may keep them presentable a long time; how-

ever, if repeatedly repressed in this way they may become too smooth and formal. Pruning must be carefully done, so that there will be no conspicuous bare spots during the following winter when they are expected to be most attractive; also, too much foliage should not be removed, since with many kinds new foliage does not develop on those parts of branches where the needles have died, and it develops very slowly with many others. Broadleaf evergreens may be similarly pruned to be kept in more compact form than they naturally assume, or, if growing too large, they may be repressed as just described.

The pruning of deciduous shrubs should maintain the natural form and outline of growth, except in the few cases where they are used in extremely formal design, including hedges. Occasionally collections of shrubs are seen where each one is trimmed in the same general form as its neighbor, even though they are naturally different in outline and character (fig. 31). Such pruning not only detracts from the natural beauty of the plant, but lessens the attractiveness of the group and usually destroys the possibility of a crop of flowers. On the other hand, in formal designs shearing is often desirable to keep the plants in the shape required to conform to their surroundings (fig. 24).

The pruning of hedges should produce the general effect desired—a loose, informal growth over the surface, smooth, formal lines and surfaces, or an intermediate effect. The smooth, formal lines and surfaces are produced by shearing once or twice a year or oftener; informal effects by clipping out branches that are becoming too rampant or that are getting beyond bounds. Such branches should be entirely removed by a smooth cut at a crotch. Stubs should be studiously avoided in this type of pruning, while in shearing little attention is given to whether stubs are left or not.

PRUNING FOR FLOWERS

The flowering of woody plants may be modified by pruning. The usual purpose is to produce a maximum of attractive bloom, but in some cases the aim is fewer flowers of greater perfection or size, or larger clusters. Free blooming is promoted by vigorous growth com-

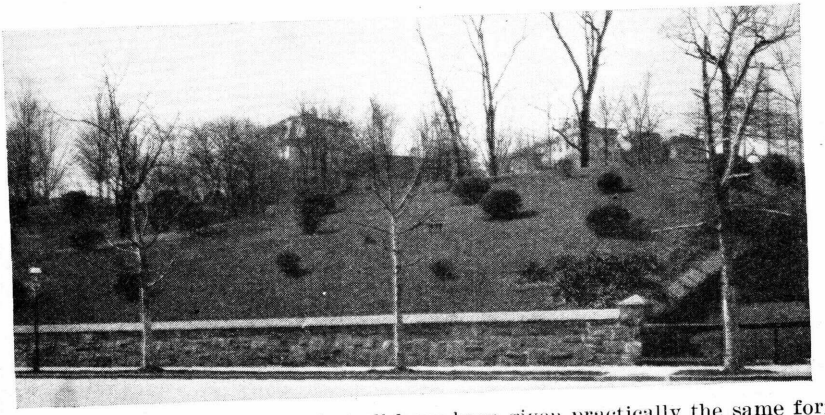

FIGURE 31.—Shrubs pruned so that all have been given practically the same form instead of the various outlines natural to them.

bined with conditions favorable for the formation of flower beds, including sufficient moisture, suitable temperature, and ample fertility at the proper season.

The flower buds of spring-flowering plants are formed in late summer or early fall of the previous year; flower buds on summer and autumn flowering plants are formed during the early part of the year in which they flower. Some late spring and early summer flowering plants such as everblooming roses (the Bengals, Chinas, or Bourbons, hybrid perpetuals, Noisettes, and teas with their hybrids) form their flower buds in the spring. These plants flower early in the season on new growth originating on wood of any age.[3]

Woody plants grown for their flowers usually should be pruned just after they are through blooming and before new flower buds form. This means the pruning of spring- and early-summer-flowering plants while in active growth, and of late-summer and autumn-flowering plants any time after flowering before growth starts in the spring. Late-blooming plants hardy in any region may be pruned when most convenient during this period, but those inclined to be the least tender would better be left unpruned until spring. As many of the everblooming roses are somewhat tender in much of the territory where they are grown, it is usually best to leave pruning until spring. Tender plants left unpruned in the fall often may be somewhat winter-killed, but will not be so severely injured but that satisfactory flowering will follow the next season. On the other hand, if the plant is pruned and is then winter-killed, there may not be enough wood left to produce the desired flowers that season. Another reason for delaying the pruning of tender plants until spring is the possibility that pruned plants may kill back farther from the ends of cut branches than from uncut ones.

Flowering trees and most shrubs need only to have weak and crossing branches removed and wood that will no longer flower freely. Shrubs that produce several shoots from the ground generally require the removal of the older ones from time to time; the frequency of such removal depends on the kind and age of the plant and the conditions under which it is growing.

With some shrubs the period of greatest flowering is 3 or 4 years or less. An example of this is the common mockorange of the North (called syringa, but better *Philadelphus*), which often becomes tall and leggy, especially if crowded or if unpruned for several years (fig. 32). Combined with this is a failure of the older wood to produce strong young shoots and many twigs die. Such a condition requires the removal of some of the old growth at the ground at least every 2 years, to give the young growth a chance to develop and form flower buds. It also stimulates the development of strong young shoots from the ground that will bloom the next year. The old wood of rugosa roses can be removed to advantage as soon as the hips become unattractive. It is advisable to remove the 3-year-old canes each winter, as new canes come from the ground every year. If a strong side shoot is produced from an old cane, it may be well to remove only the part above the side shoot. Such treatment keeps

[3] For information concerning the care of roses consult Farmers' Bulletin 750, Roses for the Home.

the bush from becoming full of old wood that is of little value for flowering.

Other examples of shrubs likely to need this kind of treatment are many rose species, deutzias, spireas, golden bells, bush dogwoods, abelia, and weigelia.

Some shrubs also send up many shoots under certain conditions and only a few under others, but do not require the frequent pruning just described. Often shrubs of this habit may keep in good condition without severe thinning or renewal for 15 years or more; on the other hand they may at times be improved in form and flower-

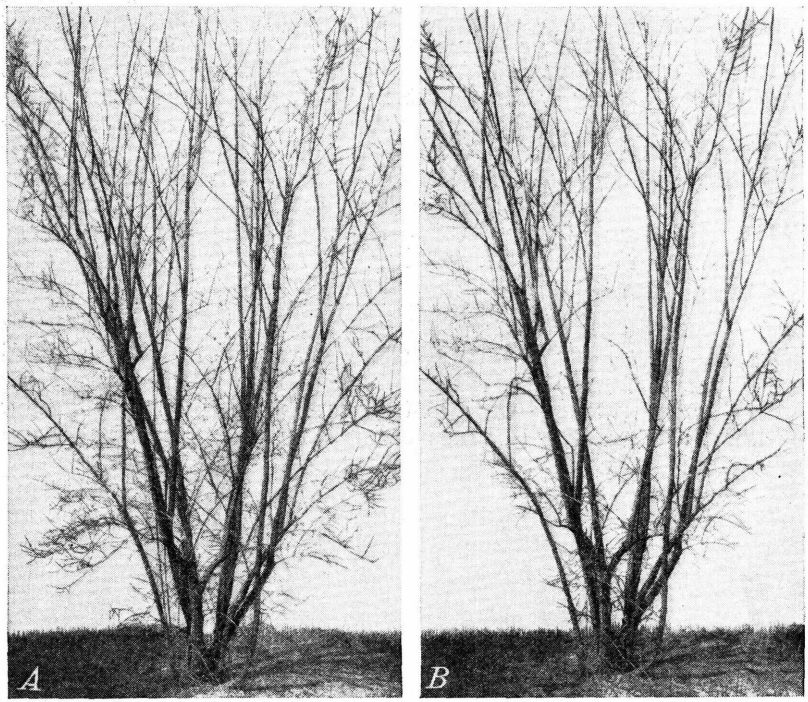

FIGURE 32.—*Philadelphus* (the shrub known in the North as mockorange): *A*, Before winter pruning; *B*, with weak and crossing shoots removed. The main pruning should be done in June, after flowering.

ing by a renewal of the top. Examples of this type of plants are lilacs, viburnums, flowering currant, coralberry, snowberry, privets, azaleas, camellias, Cape-jasmines, rhododendrons, and laurels.

Certain shrubs are usually injured in appearance if there is any attempt at a general renewal. These plants normally grow with two or three trunklike stems from the ground, and the top can be neither partially nor entirely headed back without destroying the form (see fig. 23). Usually all than can advantageously be done with such plants is to thin out the branches and moderately head back the outside branches (fig. 33). Examples of this type of shrub are bush-honeysuckles, sweet shrubs, rose-of-Sharon (or shrub-althea), and crapemyrtle.

Severe pruning changes the general character of flowering with a few plants; slight pruning produces many small flower clusters, severe pruning (figs. 34 and 43) fewer but larger clusters, usually on much longer stems. Two conspicuous examples of this are the fall hydrangea (*Hydrangea paniculata grandiflora*) sometimes called peegee hydrangea and the crapemyrtle.

No hesitation should be felt about sacrificing flower buds if weak or crossing branches need removal, or if other change in the form of the plant seems urgent. If shrubs grown for their showy berries are pruned just after the plants are through flowering, the possibility of a maximum crop of berries is reduced by the amount of pruning that is done. It usually is better to sacrifice bloom by doing needed pruning in early spring rather than to prune after flowering, for the latter would not only remove the berries on the branches cut out, but the operation might knock newly set berries from other branches. A further reason for dormant spring pruning of spring-flowering berry-bearing shrubs is that many of them do not have conspicuous flowers, so that a reduction of the number of flowers would not be important. Plants that have showy flowers and berries should be so pruned as to develop the characteristic most desired. Fortunately, most berry-bearing shrubs require little pruning.

TIME TO PRUNE

Except for rapidity of healing there is apparently very little difference in the ultimate results of pruning done at different seasons. Wounds made toward the end of the vigorous spring growth (about the first of June near the thirty-eighth parallel) usually heal more quickly than at other seasons, whereas those made when growth is almost completed (August in the same general region) heal more slowly than those made at other times.

Sap flows rather freely from some plants when wounds are made at certain seasons. Although such "bleeding," as it is called, seldom is markedly injurious, the loss of sap wastes nutritive material that could be used to advantage, makes difficult or impossible the application of protective coatings, and distresses lovers of plants. For these reasons other seasons should be selected for pruning when possible, although there should be no hesitation about proceeding with any cuts that may be urgent. Maples especially bleed freely in late winter and early spring. Wounds on trees with resinous sap, such as the cone-bearing evergreens, do not bleed when cut, and in many cases the dried sap provides as efficient a protective covering as would paint or other materials.

Though little pruning is ordinarily required, plants should be inspected frequently so that needed work may be done promptly. Dead-wood and lack of vigor are most easily detected in summer, but poor form, crossing branches, and bad crotches may be more readily discerned in deciduous plants at other seasons.

Pruning woody plants for vigor is usually best done as soon as the need for it is apparent. Prompt action is often an important part of the treatment.

Evergreens are best pruned for form at the time when growth is about to become active either in the spring or midsummer, so that

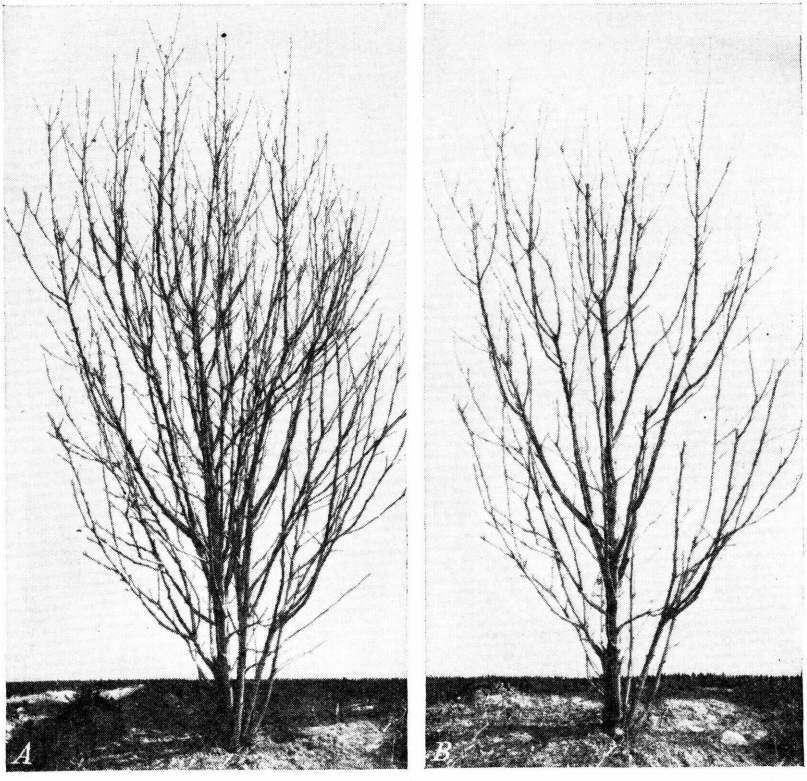

FIGURE 33.—Rose-of-Sharon: *A*, Before pruning: *B*, after pruning. The pruning of late-flowering plants like this should all be done during the dormant season.

FIGURE 34.—Crapemyrtle: *A*, Unpruned; *B*, pruned for mass effect rather than for size of flower clusters, which would require more severe pruning.

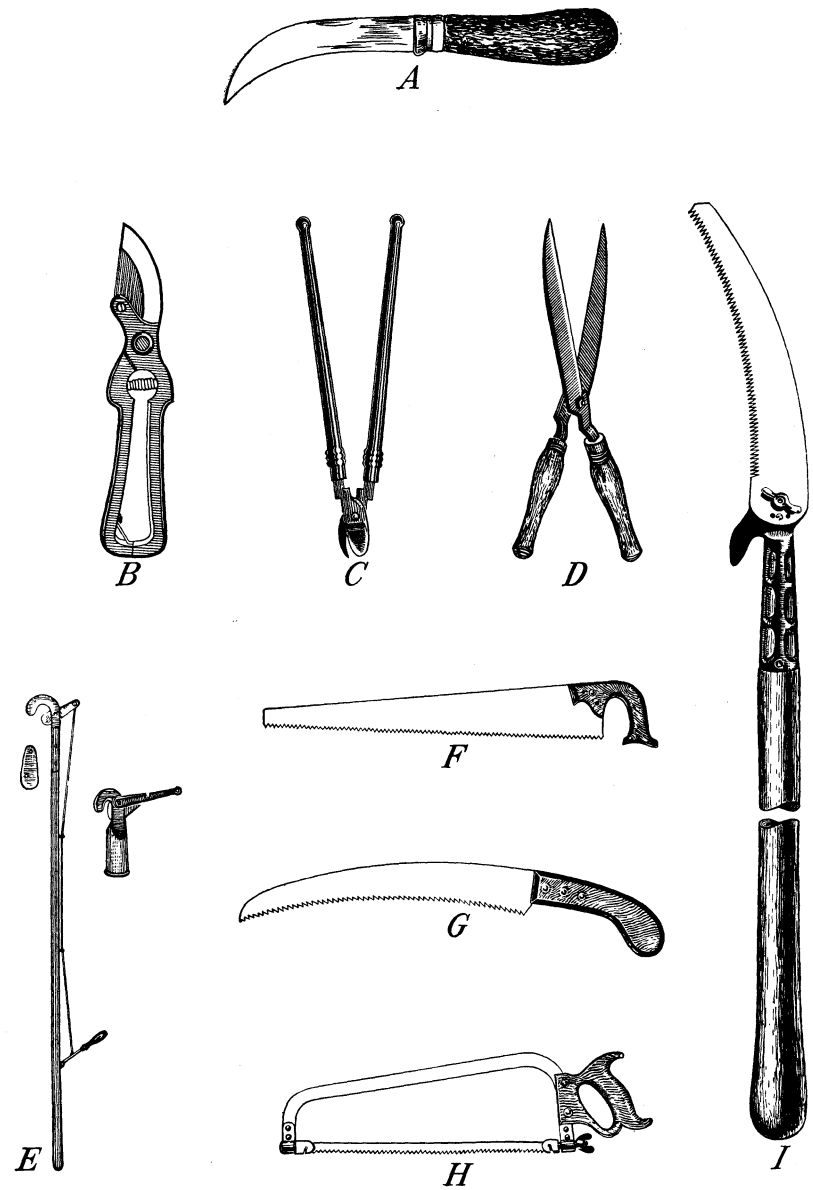

FIGURE 35.—Pruning tools: *A*, Hawkbill knife, the very best pruning tool, but only practicable for small branches; *B*, pruning shears; *C*, lopping shears; *D*, hedge shears; *E*, pole shears for cutting small limbs beyond the reach of other tools; *F*, saw, probably the best tool for limbs too large for the pruning knife; *G*, *H*, other forms of saws, especially useful in some difficult situations; the blade of *H* can be turned at any angle to the frame; *I*, a long-handled saw often useful for the ends of tree limbs otherwise difficult to reach and too large to cut with pole shears.

any thin-foliaged or otherwise unsightly places resulting from the pruning will be exposed to view for the shortest possible time.

METHODS OF PRUNING

It is important that cuts on trees and shrubs be made at the right place, in the proper manner, with efficient tools, well-handled.

The best tool for pruning is a sharp knife (fig. 35, *A*). Of course, it can be used only on comparatively small branches, but with it clean cuts can be made. Pruning shears are much used, but they crush the branch and thus prevent rapid healing. Hedge shears are usually made with two cutting blades and are better than either pruning or clipping shears. Long-poled pruning shears are frequently very convenient for use on the ends of limbs. One-edged saws from the ordinary keyhole saw up to fairly large hand saws are essential for larger cuts. Rather fine-toothed ones should always be used, but the size will depend upon the work to be done. Some workers even like the

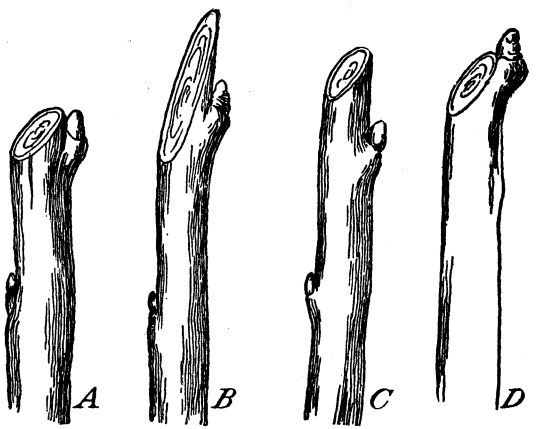

FIGURE 36.—Right and wrong ways of cutting off shoots: *A*, Right way; *B*, *C*, *D*, wrong ways.

adjustable meat saw. A small saw with a handle like the pole shears is frequently convenient. Two-edged saws are not good, as the back will often scarify the remaining branches while the cut is being made in the proper way.

As much of the pruning as possible should be done with a knife while the branches are small. Often much can be done with young plants by pinching out growing shoots, cutting only occasionally. In cutting twigs a diagonal stroke beginning about opposite the lower edge of the bud and terminating slightly above it (fig. 36) is best. If the cut is properly made (fig. 36, *A*) it will heal promptly. If too much wood is left above the bud (fig. 36, *B* and *C*) the cut surface cannot heal, and the twig beyond the bud will die. If the cut is too close to the bud (fig. 36, *D*) there is danger of the bud dying through excessive drying of the immediately adjacent parts.

When it is desired to remove some of the current season's growth to repress especially vigorously growing plants with no side branches

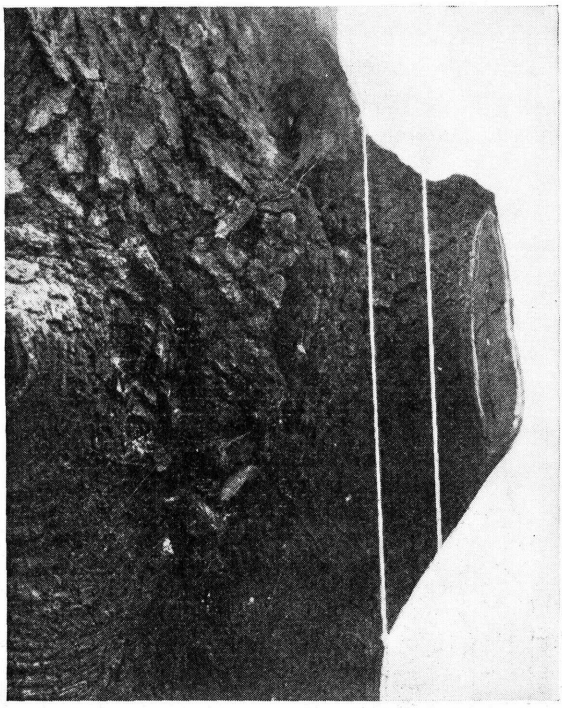

FIGURE 37.—Part of a tree trunk showing where a cut should be made in removing a limb from a tree. The original cut was made so far from the tree that healing is not taking place, though it is several years since the cut was made. Had the limb been cut between the white lines it would have healed promptly.

to which to cut, the cut should be made to a strong bud pointing in the direction it is desired the new growth should go.

To cut off stubs or larger limbs, make the cut at a crotch nearly parallel to the supporting branch and close to it. In this manner the cambium or growing layer, which is between the outer bark and the wood, will grow over the cut surface. Such a cut should be made through the swelling at the base of the branch (fig. 37) that is called a collar; growth of the cambium over the wound is then almost sure to follow.

If a cut is made beyond the collar, healing in many cases will not take place. In any neighborhood it is very easy to observe stubs that are not healing because the cut was not made close enough to the supporting branch. Often the wound made by cutting through the collar leaves much more surface exposed than one made farther out, but the ultimate result from a cut well made, even though twice as large, warrants making the larger wound. Stubs are extremely inimical to the health of plants, as they soon rot, thus permitting decay to enter trunk or limbs where it is impossible to stop it.

It is important that every branch be so removed that it will not tear bark from the tree. This is done with larger limbs by making four cuts, two to remove the limb and the other two to remove the re-

maining stub. The limb can best be removed by sawing into the lower side 12 to 24 inches from the final cut, depending on its size, and as nearly halfway through as can be done without the saw being pinched by the sagging of the branch. Then a cut should be made from the top of the branch 3 or 4 inches farther out (fig. 38, *A*). When the limb is sufficiently cut it will break off without tearing bark from the portions that are to remain on the tree (fig. 38, *B*).

The stub is then removed by first cutting through the bark and well into the branch from the lower side and in line with the cut to be made from above, by which the stub is to be severed. A cut is then made from above, and if the work is well done so that the two cuts meet the stub is removed without tearing bark from the branch below the cut (fig. 38, *C*). With the final cuts made close to the remaining branch (fig. 38, *D*) and almost parallel to it, healing will begin promptly (fig. 38, *E*), and ultimately bark will completely cover the wound if it is well protected from rot fungi. For ease of handling, such a stub should be as short as is safe to provide protection from stripping the bark when the branch is being cut. In re-

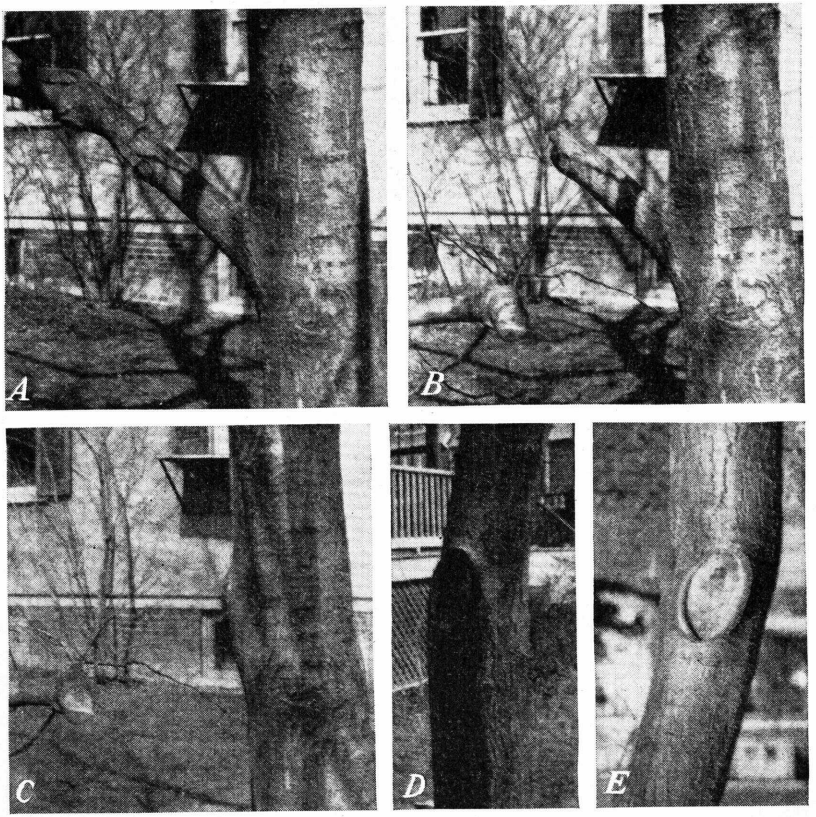

FIGURE 38.—Removing a limb from a tree: *A*, Cut made from below and then one from above; *B*, the limb removed; *C*, the stub removed close to the tree by an under cut and then a top cut; *D*, the fresh wound as viewed from the front; *E*, the wound as it appeared after a season's growth, with the cambium layer beginning to fold over the cut surface, much at the sides, and a little at the top and bottom.

moving the stub it is occasionally desirable to split off portions of it (fig. 39) as the cutting proceeds, so as to make its support easier as the cutting nears completion.

Another method of preventing bark from tearing from the tree is to so support the limb to be removed by a rope or prop that the base of the limb will rise when severed and tear the bark from the branch instead of the tree (fig. 40).[4]

All cuts should be so made that they will shed water and immediately after being cut should be treated with some protective material, unless bleeding of the wound necessitates a temporary delay.

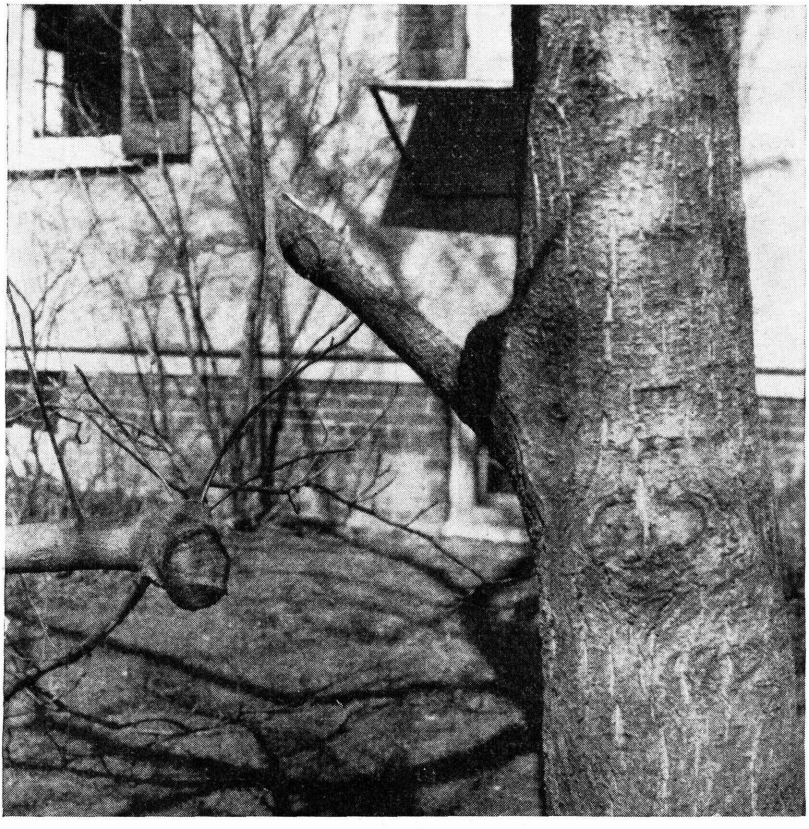

FIGURE 39.—A stub partially split off in the process of removal.

There are many materials that can be used,[5] but for the care of a few plants probably there is none more convenient and satisfactory than ordinary shellac painted over the cut edge of the bark at least one-half inch outside and 1 inch inside within 5 minutes of the time the cut is made. The central portion of the cut should then be painted with house paint, creosote, or other good wood preservative, lapping

[4] This illustration is taken from Farmers' Bulletin 1726, Treatment and Care of Tree Wounds, which contains much information on the care of wounds.

[5] For a discussion of the various materials available for this purpose and methods of applying them, consult Farmers' Bulletin 1726, Treatment and Care of Tree Wounds.

over the edge of the shellac, but not so far that it reaches either the cut or uncut bark. Shellac protects the inner bark or cambium layer from undue drying. It could be used over the whole surface, but it would have to be renewed frequently, making it more expensive than other materials suitable for preserving wood. The better wood preservatives are injurious to growing parts. Cut surfaces should be repainted as often as necessary, perhaps every other year, to furnish complete protection until covered by newly grown bark. Usually shellac will last until the bark is grown over it, and the repeated paintings are made so that the wood will be preserved until the bark has covered the other portions of the wound. If the paint is permitted to weather off before it is covered by bark, the area near the bark must be coated with shellac and the center again painted. With shrubs the same methods of treatment hold—a touch of shellac for small wounds and permanent wood preservative in the center of larger ones.

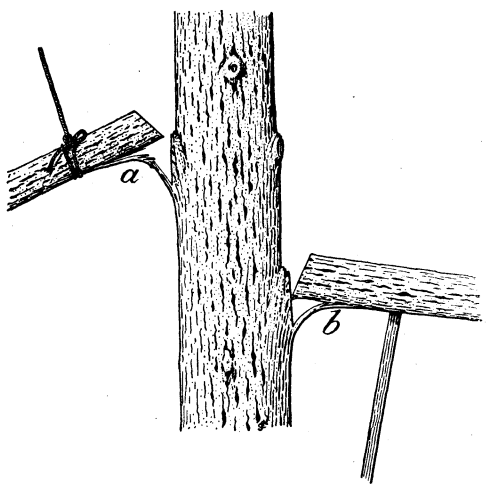

FIGURE 40.—A heavy limb can often be removed with a single downward cut if the limb is supported with a rope tightly drawn, as shown at *A*, or by a prop firmly placed, as shown at *B*. This causes the cut end to lift as the limb falls. Either rope or prop should be slanted so that the limb will swing away from the trunk as it is severed. If the rope is tied to a living overhead branch, the latter should be well padded to prevent injury, and allowance must be made for the bending of this branch under the weight of the severed one.

In pruning to formal outline, cutting at crotches is frequently considered too slow; also it does not produce as smooth a surface as clipping without reference to crotches or even to the effect on the individual leaves. Sometimes the surface is so clipped that parts of leaves are left on the larger leaved plants by running long-bladed pruning shears over the surface of the plant and clipping new growths that extend beyond the general surface. It is also done by using a sharp sickle with an upward stroke, or by a specially constructed machine with sickle blades similar to a diminutive moving machine, operated mechanically or electrically. These methods mutilate the leaves. Such mutilation is more apparent in broadleaf trees, whether evergreen or deciduous, than in coniferous trees.

PESTS

Ornamental plants, like other forms of vegetation, are subject to various attacks of quadrupeds, insects, mites, and parasitic plant diseases. Only trees and shrubs suited to the soil, climate, and exposure should be selected, as plants in uncongenial surroundings are

likely to be unthrifty and are then more subject to attacks of insects and diseases. Healthy plants are not only less susceptible to the attacks of pests but are also more able to overcome the effects of such attacks.

A special help against many insects is the presence of insectivorous birds. These are encouraged to live where there are trees and thick clumps of shrubs that are a protection to them and provide favorite nesting places for many species. The inclusion of berry-bearing plants, especially those that provide berries at the season when food is likely to be scarce, is also desirable. Protection of the birds from their archenemy the cat is important.

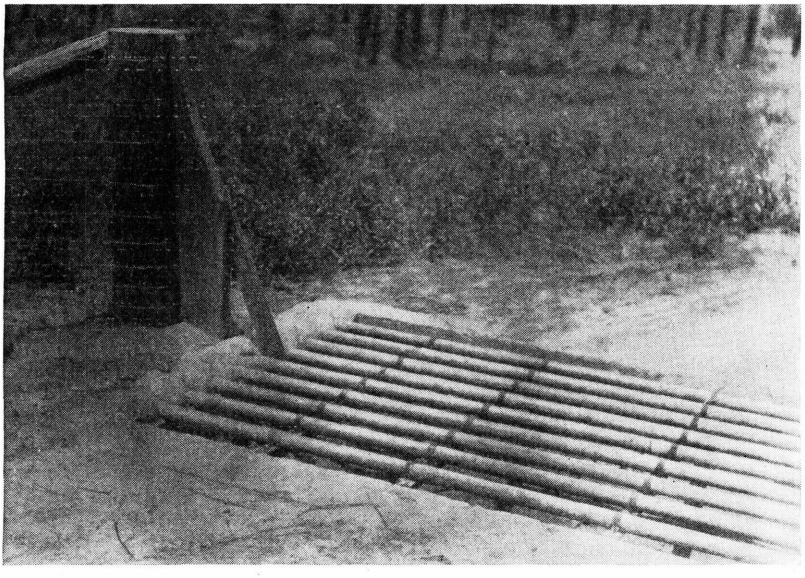

FIGURE 41.—A gateway protected from roving livestock by a cattle guard consisting of a well-drained pit 2 feet deep, covered by old boiler tubes or 4-inch pipes on 6-inch centers that permit the crossing of automobiles, but exclude all types of domestic livestock, including most dogs.

ANIMALS

Roving cattle are a menace to ornamental plants in many places. Fencing or protection by suitable guards is the best way to curb this annoyance, both in regions where there is a law against permitting stock to rove but no public sentiment to enforce it and in places where no such law exists. Fencing is especially annoying when automobile gates are necessary. This inconvenience can be overcome, however, by using cattle guards made of 4-inch pipe or old boiler tubes placed on 6-inch centers over a pit 2 feet deep and 5 or 6 feet wide that will prevent the entrance of most livestock, including poultry, unless badly scared, and usually dogs (fig. 41).

A pest of ornamental plants difficult to handle in towns, villages, and suburbs throughout the country is dogs. They destroy the plants by urinating on them, boxwood being an object of very special atten-

tion, but any plant will succumb in a region where a large number of dogs are permitted to run at large. In a capital city it has been found impossible to maintain even *Rosa rugosa* and *Berberis thunbergii* on a conspicuous parkway because of dogs. They also do damage by scratching in the soil about the plants. To the extent that a property owner may not kill dogs to protect his property, they are domestic animals; but unlike other domestic animals, apparently they cannot be checked by any enforceable method.

Appeal to the owners for restraint is usually not only useless but almost always considered insulting, and enforcement by appeal to courts of law is not practicable. Extremely temporary protection from this trouble may be obtained by spraying the plants with nicotine sulfate, 1 ounce to 1 gallon of water, or dusting with cayenne or black pepper, but the effects are so extremely fleeting that they can hardly be classed as practicable. Commercial products are advertised for the purpose, and it is hoped a product will soon be developed that will prove effective in control.

Occasionally rabbits destroy small plants by gnawing the bark; usually this occurs only when snow is on the ground and other food scarce. Sometimes protection may be provided by woven-wire fences about the group of plants or wire or paper collars extending farther up the plants than a rabbit can reach.[6]

Rats sometimes become troublesome even at a considerable distance from buildings. They can usually be caught with a box rabbit trap, first baited a little without setting the fall, and thus getting the rats accustomed to eating tidbits in the trap, so that they become used to it and rat odor is about it.[7]

Field mice are often very destructive, eating the roots and gnawing the bark at any season. They follow mole runs and make runs of their own that are sometimes attributed to moles, although as a rule theirs are not so close to the surface. Much of the damage attributed to moles is caused by these pests. Moles may lift a shallow-rooted plant by burrowing under it, but this seldom happens, and they do not eat the roots as do the mice. Mice may be killed by placing poisoned bait near their haunts in traps that safeguard the bait from birds and other animals.[8]

INSECTS [9]

In considering the relation between insects and ornamental plants the first thing to emphasize is that healthy, vigorous, and uninjured trees and shrubs are least likely to be infested by certain kinds of insects, such as borers, or to be seriously affected by their attacks. It is therefore important that the methods suggested in this bulletin for the care of trees and shrubs be followed as means of preventing insect attacks and minimizing the injury they cause.

Insects injure plants in many different ways, and the method of controlling them depends largely upon the mode of attack. Insects

[6] For further information consult Farmers' Bulletin 702, Cottontail Rabbits in Relation to Trees and Farm Crops.

[7] For further information consult Farmers' Bulletin 1533, Rat Control.

[8] For further information on control of mice see Farmers' Bulletin 1397, Mouse Control in Field and Orchard.

[9] Prepared by William Middleton, entomologist, Division of Japanese Beetle Control, formerly Division of Forest Insects, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

that infest trees and shrubs can be grouped according to their chief method of attack as follows: (1) Those that eat the leaves; (2) those that mine the leaves; (3) those that bore in the bark or wood; (4) those that suck juices from the leaves, fruit, bark, or roots; and (5) those that make galls on the leaves, twigs, fruit, or roots.

LEAF-EATING INSECTS

Many caterpillars, sawfly larvae, and beetles and their grubs feed upon ornamental trees and shrubs by eating the leaves. Their work is both injurious and unsightly. A number of methods are available for combating such insects, some depending on particular knowledge of the exact species involved. However, the one rather general method that will nearly always give the desired result consists in spraying the foliage with a mixture of lead arsenate and fish oil or linseed oil. This mixture should be prepared in the proportion of 4 to 5 level teaspoonfuls of powdered lead arsenate and 1 tablespoonful of fish oil or linseed oil to 1 gallon of water, or, in larger quantities, of 2 pounds of powdered lead arsenate and 1 pint of fish oil or linseed oil to 50 gallons of water. The material should be kept well mixed while being applied. Care should be taken to coat both surfaces of the leaves, but especially the surface where most of the eating is done. The application should be made as early as possible in the life of the caterpillar or other feeding stage of the insect, preferably when it is just beginning to eat the leaves.

LEAF-MINING INSECTS

Some caterpillars, sawfly larvae, beetle grubs, and fly maggots feed upon ornamental trees and shrubs by eating the interior tissue of the leaves while leaving the outer surfaces intact. These insects are generally difficult to control, because they and their food material are protected from sprays by the epidermis of the leaves. Control by any means other than the collection and burning of the infested leaves depends upon the behavior of the particular species involved.

WOOD- AND BARK-BORING INSECTS

Most of the wood- and bark-boring insects are beetles and their grubs, but there are a few caterpillars, wood wasps, and carpenter bees and ants which also attack plants in this manner.

Borers that attack by preference plants in good condition are called primary borers; those that infest only weakened, injured, or dying plants are called secondary borers. Borers that attack ornamental trees and shrubs are usually of the latter class.

In an attack by primary borers the danger to other plants is so serious that all of the infested material should be removed and destroyed as soon as it is located.

The prevention of injury by secondary borers is of the greatest importance. Trees and shrubs should be kept growing vigorously if possible. Mechanical injury to the plants should be avoided, and any that does occur should be attended to promptly. Wounds should be cleaned out and kept shellacked or otherwise treated until they heal. Through these measures much damage by boring insects can be prevented.

When attacked, the infested portion can be removed or, in many cases, the borers can be killed by injecting a teaspoonful of carbon

disulfide into the insect galleries and plugging the openings tightly for several days. An oilcan may be used for this purpose. The liquid should be handled with care, as it is explosively inflammable and its vapors are poisonous. Sometimes borers can be killed by running flexible wires into their burrows.

SUCKING INSECTS AND MITES

The sucking insects and mites that attack plants may be divided into two groups on the basis of their resistance to spray materials—unprotected sucking insects and mites and scale insects.

The unprotected sucking insects, such as aphids, plant bugs, lacebugs, and mites, are usually successfully combated by sprays containing nicotine sulfate, pyrethrum, or derris, or combinations of these materials with soap. These sprays must come in contact with the bodies of the insects or mites to be effective. Probably the most common spray of this type in use at the present time is prepared according to the formula nicotine sulfate (40 percent) 1¼ teaspoonfuls, soap 1 ounce, and water 1 gallon.

The scale insects and their relatives are frequently shielded from spray materials by their scale coverings or by some waxy or other body secretion. The young ones can be controlled with the nicotine sulfate and soap spray and other mild contact sprays, but the older ones generally require spraying with somewhat strong miscible oil or oil-emulsion sprays or a lime-sulfur mixture. Because these materials, especially the oil sprays at the dilution required, are likely to injure leaves and the softer growth they are generally applied when the plants are dormant and in a diluted form called "dormant strength."

Many reliable commercial brands of sprays for scale insects are on the market, and each package bears directions for its use. It is important to follow these instructions closely.

GALL-MAKING INSECTS

Several kinds of insects cause the formation of galls or abnormal growths on plants. Aphids and their relatives, wasps, flies, mites, moths, and even beetles may cause swellings of the infested plant tissue that can be called galls.

The insects producing the galls are often difficult to combat successfully by other means than cutting and burning the growths. The galls should be removed and destroyed when they contain the gall makers which feed and develop within them. Other measures of control are sometimes available, but a knowledge of the particular gall maker involved is necessary before advice can be given as to the proper method.[10]

FUNGUS AND OTHER DISEASES OF TREES[11]

Throughout the life of a tree all its parts are subject to disease caused by unfavorable environment and by parasitic plants such as

[10] For serious insect problems of trees and shrubs it is recommended that a specimen of the insect and its work, with a brief account of the plant and its difficulty, be forwarded to the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Washington, D. C., for examination and direct reply. The insect should be sent dead, in alcohol or formalin, and the package should be carefully wrapped and marked plainly with the sender's name and address. Farmers' Bulletin 1169, Insects Injurious to Deciduous Shade Trees and Their Control, gives information helpful in the case of these plants.

[11] Prepared by the Division of Forest Pathology, Bureau of Plant Industry, U. S. Department of Agriculture.

bacteria and fungi, low types of plants without true flowers or seeds. In some places mistletoe is a distinct menace to trees, but tree diseases are commonly caused by a great variety of fungi, often invisible to the naked eye. As several organisms and unfavorable environmental conditions may produce similar symptoms, the specific cause of a disease can often be determined only by careful study by specialists on tree diseases. Adequate descriptions of even the most common tree diseases would fill a book; therefore only a few types of diseases can be mentioned briefly here.

On leaves fungi may cause abnormal growths or more or less well-defined spots or irregular blotches of varying size and color; they may destroy certain areas, wilt or discolor the whole leaf, cause premature defoliation, or become evident in some other way. Diseased leaves, although often unsightly, commonly cause no serious or permanent injury unless they are present in great abundance over the whole tree. The development of a leaf disease generally is closely related to weather conditions, which the following year may decrease in severity. If a tree is of sufficient value to warrant the expense and the leaf disease is severe enough to make control measures advisable, bordeaux mixture, lime-sulfur spray, or sulfur dust can be applied after obtaining advice about the strength suitable for the particular tree.

On twigs, branches, or trunks fungi may produce such symptoms as abnormal growth, discoloration, raised or sunken cankers, or possibly may cause the death of the bark and underlying wood. Twig and branch diseases often can be removed by pruning well back of the infected portions. In certain cases even cankers can be cut out of trunks. Wounds made by removing diseased parts should be treated with shellac and protective dressings as recommended in Farmers' Bulletin 1726, Treatment and Care of Tree Wounds.

The diseased portions removed should be burned to prevent the spread of the disease. It may also be advisable to collect all leaves and twigs from diseased or unhealthy trees, particularly in the autumn, and destroy them by burning, even though no pruning or other special attention has been given to the tree.

Rusts, a class of diseases like white-pine blister rust that usually live on two alternate hosts, sometimes occur on leaves or needles and at other times on branches or trunks of trees. These rusts are best controlled by the eradication of the less valuable host.

Wilts constitute a group of tree diseases often caused by the growth of fungi in the vascular system. These fungi may discolor the wood as does the Dutch elm disease.

Root diseases of trees cause various symptoms, such as slow growth, thin foliage, premature defoliation, and death of certain branches. It is often difficult to diagnose or cure them.

The decays and cavities that fungi cause in trees by entering through neglected wounds can usually be prevented by properly sterilizing the original injuries as soon as they occur and by treating the exposed wood with a protective dressing, as recommended in Farmers' Bulletin 1726.

Inquiries about diseased trees should be addressed to the Division of Forest Pathology, United States Department of Agriculture, Washington, D. C. These should be accompanied, if possible, by

generous representative, carefully labeled specimens of the unhealthy portions of the tree, as well as by the living portions adjoining the affected parts, and by a description of the general environmental conditions under which the tree is growing.

FUNGUS AND OTHER DISEASES OF SHRUBS [12]

Some of the common diseases of shrubs and their treatment are here discussed.

SPECIAL CONTROL RECOMMENDATIONS

BOX LEAF CAST AND TWIG BLIGHT

Keep the branches free of debris from fallen leaves, to avoid box leaf cast and twig blight. Provide protection against excessive sun and against cold drying winds in winter. Spray with lime-sulphur (summer strength) just before spring growth begins and at intervals until growth ceases in late summer.

CEDAR "APPLES"

The galls on red cedars and junipers called cedar "apples" are caused by the fungus of the pome fruits that passes part of its yearly cycle on each of two kinds of hosts. One type of cedar-apple fungus forms the rust stage on flowering as well as fruit-bearing species of *Malus* (apple); another on *Cydonia* (quince), and another on *Crataegus* (hawthorn). It is impracticable to grow cedars (junipers) in close proximity to any kind of the other hosts. The Chinese junipers in general are resistant to the rust fungus; aborvitae and retinospora are entirely immune.

HYDRANGEA BLIGHT AND DIEBACK

The dying of hydrangea shoots at the tip more commonly results from late spring frosts or from a sudden check due to drought or heat following a period of rapid growth than from fungus infection. Aphid injury to young shoots is a contributing factor. There is also a fungus dieback which sometimes spreads from the old flowers. A shady and damp site is conducive to this disease, and the bushes sometimes become very unsightly. More sunlight may be the only treatment needed, but it is advisable to remove the wilted flowers promptly for the sake of appearance as well as disease prevention.

JUNIPER "BLIGHT"

Some of the "blights" of arborvitae, cedars, junipers, retinosporas, and other needle-leaved evergreens are caused by injuries in transplanting and unfavorable growing conditions, especially drought, shade, and winter injury. Similar symptoms result from a heavy infestation of spider mites, but there is also a fungus disease of this type that has become increasingly prevalent in ornamental plantings and nurseries. It causes leaf fall and death of both twigs and larger branches, and the damage on a variety of hosts is apparently due to one kind of organism. Present known remedies consist largely of improving growing conditions, especially avoiding lack of light and

[12] Prepared by Freeman Weiss, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

air in plantings of these species, and of periodic shearing. Spraying is not very practicable because of the staining of foliage, but bordeaux mixture may be used early in the growing season before new growth begins and wettable sulphur thereafter.

LILAC MILDEW

Lilac mildew can ordinarily be kept under control simply by raking up and burning all the fallen leaves around the bush at the end of the summer, as it is on these leaves that the mildew fungus lives over winter. In a shady, damp, and unventilated situation (which is no place for lilacs) spraying with wettable sulphur also may be necessary. The control of mildew of crapemyrtle is similar.

PRIVET BLIGHT

A twig-blighting fungus sometimes attacks privet hedges, ultimately killing the larger branches and entire plants. Pruning to remove parts injured during the winter, fertilization to keep up vigor, and dormant spraying with lime-sulphur will ordinarily give adequate protection.

RHODODENDRON BLIGHT

A dieback of rhododendrons often starts in the withered flowers; it is therefore important to cut these off promptly after they have bloomed. The same disease may also attack leaves and young shoots directly, but this is likely to happen only in excessively shady and damp situations. Under these conditions an application of bordeaux mixture after the flowering period and a second one in late summer will aid in control.

SPRAYS AND DUSTS [13]

Troubles with ornamental plants are not likely to be as serious as with fruit and vegetable crops because ornamental plantings usually are composed of several kinds of plants. Nurseries frequently need to spray blocks of plants, and occasional spraying is desirable on both public and private grounds for specific troubles. Sometimes diseased plants or parts of plants should be removed and burned. Advice from the nearest agricultural experiment station or the United States Department of Agriculture is desirable in connection with any unknown trouble. The better informed the cultivator is concerning plant enemies, the more successful he is likely to be in warding off trouble.

Troubles that attack more than one kind of plant at different stages of its development may often be controlled by the elimination of one host plant where the commercial importance seems to warrant.

Spraying or dusting is not in any sense a stimulating panacea. Sprays and dusts are likely to be directly injurious to the plants, although often helpful in preventing the attack of insects or diseases. Because of the possible injurious effects and because spray residues disfigure the surfaces to which they adhere, spraying should be done only to combat some known pest.

[13] Prepared in cooperation with Freeman Weiss, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

It is important to remember that the chief purpose of fungicidal spray is protection against infection; it is generally preventive rather than curative. Spraying should be done, if at all, before a disease has affected a large part of a plant or becomes established in a group planting. There must be an opportunity for new growth to occur in order that recovery from the disease may be brought about, and the spraying is done more to keep the new growth from becoming infected than to cure parts already attacked. In some cases only the aged leaves are subject to infection. Against surface mildews and sooty molds a spray may be both preventive and curative, as the fungus growth is largely superficial. Fungus parasites are often distributed and usually gain entrance into the plants during periods of wet weather; therefore, in order to secure the maximum benefit from sprays, they should be applied before rather than after rains.

Some diseases are best controlled by spraying during the dormant season. As deciduous plants are without foliage at this time, and the mature leaves of evergreens are protected by impervious coatings of cutin and resin, spray concentrations that could not be used on summer foliage are practicable.

BORDEAUX MIXTURE

This general-purpose fungicide is as effective as any known against most pathogenic fungi and bacteria and is safe to use on most kinds of ornamental shrubs, including evergreens. The chief objection to its use on ornamental shrubs is the bluish-white deposit left on the leaves; generally the better the bordeaux mixture the more persistent the deposit. The residue can be made less conspicuous, where appearance is important, by reducing the quantity of lime used in the ordinary formulas for bordeaux mixture; however, it is possible to reduce the lime too much, with the result that the spray is inferior in adhesiveness and likely to damage the foliage because of free copper sulfate.

The customary formula for home-made bordeaux mixture is 1 pound of copper sulfate (bluestone), 1½ pounds of hydrated lime, and 12 gallons of water. Bluestone in lumps should be dissolved separately in about one-fourth of the water, then added slowly, with constant stirring, to the lime suspended in the rest of the water. If the fine crystalline form of bluestone called "snow" is available, the requisite quantity may be placed on a fine screen and water poured through it into the limewater until the bluestone is dissolved. Stirring should be continued until the addition is complete. The mixture must be freshly made and used immediately. The lime must be fresh, of a grade containing about 70 percent of calcium oxide, and of such fineness that 98 percent will pass a 300-mesh screen. To reduce the density of the residue, less lime may be used, but not less than one-half the quantity of bluestone. It is best to test any preparation of bordeaux mixture on a few of the plants to be sprayed, observing the effect after a day or two before applying the spray to a large number.

When bordeaux mixture is to be used on wax-coated leaves, as in many broad-leaved evergreens, some sort of spreading and adhesive agent should be added. Soap is effective in improving spreading, but

only a very small quantity—1 to 1½ ounces to 12 gallons of spray—may be used; otherwise a curd of copper soap will form which is relatively inert as a fungicide and which will clog the spray nozzle. Various commercial preparations are available for increasing the spreading and sticking qualities of bordeaux mixture, such as casein products, resin stickers, and oils.

Fairly effective commercial bordeaux powders on the market need only water added to form a spray mixture. Fresh packages, free from any evidence of lumps, should be insisted upon, as these powders deteriorate when exposed to the atmosphere, especially a damp one.

Bordeaux mixture may be applied with many of the materials used as insecticides, including nicotine, pyrethrum and rotenone extracts, miscible oils, and also arsenate of lead, provided an excess of lime is used.

LIME-SULFUR

Lime-sulfur is the standard material for dormant fungicidal sprays and is widely used on fruit trees of the pome and stone-fruit types. It is also used in a more dilute solution as a summer spray on orchard fruits, especially those subject to injury by copper fungicides. As the flowering types of the principal orchard-fruit genera, including *Malus* and *Prunus*, are generally subject to the same foliage and twig diseases as are the edible-fruit types, somewhat similar measures for disease control may be required. For this purpose a dormant application of lime-sulfur spray is generally advisable, and often also a spring and sometimes an early-summer application to the flower buds and young leaves, the necessity for which is determined by the presence of pests and diseases.

Lime-sulfur, as either a liquid concentrate or powder, is widely available in commercial form. For dormant spraying, i. e., when the trees or shrubs are leafless and bud growth has not begun, the standard practice is to dilute the liquid concentrate, 1 part to 10 or 12 of water, by volume; the powder is used at the rate of 1 pound to 2½ or 2¾ gallons of water. After bud growth begins or when the plants are in foliage the liquid concentrate is used at the rate of 1 part to 40 or 50 of water, by volume; the powder, one-fourth pound to 2½ gallons of water, or 1 pound to 10 gallons.

Although lime-sulfur is generally less toxic to fungi than bordeaux mixture at comparable rates of application and is preferred for summer spraying chiefly because there is less risk of damage to foliage, it has other advantages. It leaves a much less noticeable residue than bordeaux mixture and is therefore preferable for use on broad-leaved evergreens; it is more effective against certain fungi, and it possesses insecticidal properties, for example, against red spiders, which copper sprays do not have. Neither soap nor any form of oil spreader should be used with lime-sulfur.

WETTABLE SULFUR

Because both lime-sulfur and bordeaux mixture are more or less injurious to some kinds of foliage, a milder form of spray is sometimes needed. The wettable and colloidal sulfurs meet this requirement. They are available as commercial products in paste or powder form, and need only to be stirred with water to form a spray. They

are especially useful for the summer spraying of roses and for the control of mildew and true rust diseases of other plants. They leave residues as conspicuous as bordeaux or lime-sulfur, but usually they are free from any risk of burning. As with other sulfur sprays, the use of wettable sulfur with any form of oil spray, either together or in succession, must be avoided on plants bearing foliage.

SULFUR DUST

The application of sulfur in the form of a dust has come into general use as a means of combating the rose diseases, mildew and black spot. Dusting has also been extensively tested as a substitute for summer spraying in the control of orchard diseases, sometimes with fair success. It has generally proved a little less effective than spraying where the conditions were favorable for diseases, but considering the rapidity with which dusting can be accomplished as compared with spraying, a considerable gain in timeliness of application can be effected. This advantage may fully offset its usually inferior sticking power. It is of special practicability under greenhouse conditions, where the air may be confined and the dust carried uniformly to all parts of the plant, but it is also an effective outdoor disease-control measure where these requirements can be met, as on low-growing shrubs. The possibility of effective coverage by dust, at least with ordinary dust applicators, is necessarily inferior on tall shrubs, vines, or trees. Ordinary flowers of sulfur is useless as a dusting material, and even many of the samples of ground sulfur offered on the market are not fine enough. Several of the leading manufacturers of spray materials have sulfur-dust preparations that have been adequately tested and can be depended upon, but often these products are not available in the smaller towns in garden-supply stores.

The use of some material such as talc, hydrated lime, white flour, or powdered arsenate of lead increases the flowing power of sulfur dust and insures more uniform application. These materials should be mixed with pure sulfur at the rate of 1 part to 10, but are not needed where the sulfur already contains some such agent as in certain commercial products.

EQUIPMENT AND METHODS OF APPLICATION

When needed, spraying should be very carefully done. The margin between the application that will kill the insect or prevent the disease and not injure the foliage and one that is either not effective or injures the foliage is very narrow. Then, too, the equipment, whether an outfit for applying liquid sprays or for dusting, must be efficient and adapted to the work. The treatment of tall trees requires a powerful pump, one that can develop a pressure of 200 pounds per square inch at the nozzle. Such a stream should break into a fine mist by the time it reaches the tops of the trees. For low trees an outfit is needed that can produce a mistlike spray much nearer the ground, or one that will cover the trees with dust. Plants 15 feet high and less can be satisfactorily treated by various types of hand apparatus for liquids, or by tanks holding as much as 5 gallons and supplied either with pumps that work continuously while a spray is needed or with those which create pressure of air in the tank and depend on this for forcing out

the stream of liquid. Implements for handling dust and provided either with bellows or fan may also be used. Prices follow quality closely.

Liquid sprays usually withstand wetting and weather better than dusts, and the direction and amount of application can be more accurately controlled. On the other hand, dusting can be done more rapidly than spraying, and dust is less conspicuous on the foliage than the commonly used liquid sprays. There is no efficient dust for use on dormant plants.

The basis for selection of equipment, especially for low plants, whether for dust or for liquid, is a matter of personal preference, since there is no consistent difference in efficiency for summer spraying in the two methods. Some prefer to handle dusts, others liquids. The gardener should select the least troublesome outfit, so that necessary applications will be made promptly and frequently. There is little difference in the expense of the two methods.

Whether sprayer or duster is used for low plants it should be provided with an attachment that will throw the material at an angle of 90° to the delivery rod, in order to reach the under side of the leaves. For high plants a direct discharge from the end of the delivery pipe is often advantageous. A discharge nozzle at an angle of 45° is also often desirable for plants of intermediate height.

For dusting, the principal essentials are an effective device for discharging a cloud of dust which will envelop the plant, a form of material prepared especially for dusting plants, and frequent applications to replace the coating removed by rain. The bellows and pump types of duster may give satisfactory results on low plants, but in general they do not have enough power to reach taller plants effectively, and a crank or power-driven blower type of duster is preferable.

It is best to apply dusts when the foliage is dry, and of course when the air is still. Late afternoon or early evening is a favorable time.

SPECIAL NEEDS OF SOME PLANTS

Attempts are frequently made to grow plants under conditions to which the plants are not adapted. Often conditions may be successfully ameliorated so that the plant thrives. Sometimes such attention results in unsightliness or disfigurement of the landscape. In each case the cultivator must determine whether the particular plant is worth the special care required.

Plants growing near the northern limits of their possible cultivation may often be helped to resist the rigors of the climate by avoiding special growth stimulation late in the season (p. 27). Again, protection from winter sun may keep plants dormant (fig. 42) and so avoid injury from prematurely stimulated growth followed by freezing, when the same plants would have been severely injured if exposed to bright sunshine followed by the same low temperatures. Artificial shading is often beneficial, especially to newly set plants the first winter, when it may not be needed later. Trees often provide enough shade to insure the success of slightly tender shrubs.

Protection from wind at times is important, especially in regions where there are strong drying winds or those off the ocean. Such

winds are harmful alike to newly planted specimens and to plants not well adapted to such conditions. Planting to the leeward of a windbreak will sometimes mean success where failure might result in the open. Buildings, fences, and plantings of evergreens are the most effective windbreaks, although the stems of a group of deciduous plants may provide enough protection to serve the purpose. Newly planted trees frequently need to be guyed for 3 or 4 years or longer, to keep them from having their roots loosened in the soil or even from being blown over.

Wrapping shrubs in straw or in matting protects them from both wind and sun, but makes a blot on the landscape that will not be tolerated by many gardeners. Soil is one of the best protecting mate-

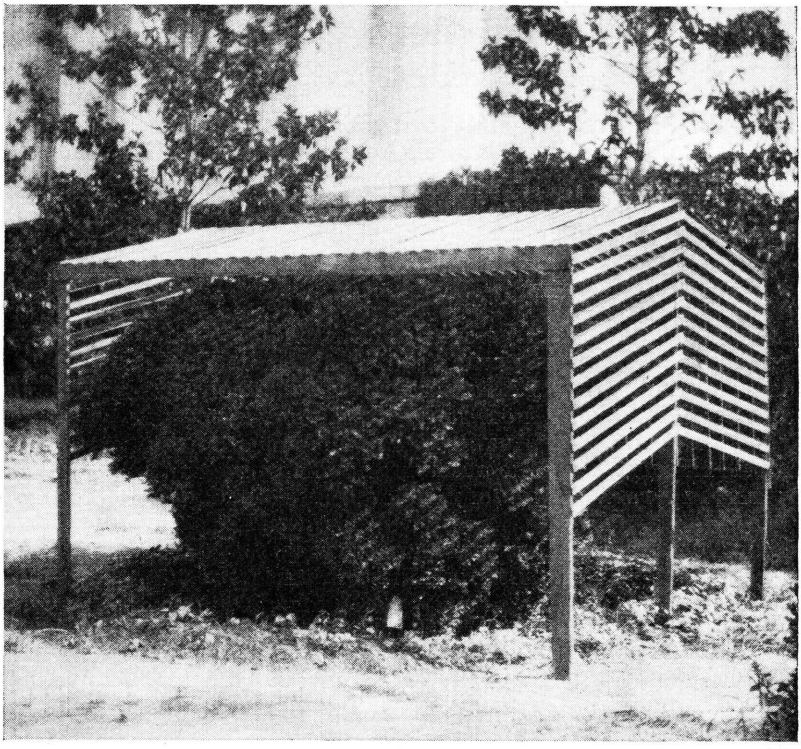

FIGURE 42.—Artificial shade for winter protection from sun of plants not entirely hardy and for the protection of newly transplanted shrubs, winter or summer.

rials, but there are only a few plants that can be covered sufficiently because of the impossibility of laying them down. Shiny leaf hydrangeas will stand having the clumps lifted and stored in a frost-free cellar and will respond satisfactorily when replanted, but there are few plants that can be handled in this way.

A few kinds of ornamental plants require special treatment in order to be satisfactory. In the following paragraphs suggestions are made as to what has frequently been found to overcome unsatisfactory behavior in these plants.

AZALEAS

Azaleas are classed by botanists with the genus *Rhododendron*, although gardeners usually make a distinction between them. However, their cultivation is the same as rhododendron and will be discussed under that heading.

BOXWOOD

Boxwood (*Buxus* spp.) does not thrive in too cold or too dry a climate. It is adapted to southern New England, southern New York, and south of the fortieth parallel of latitude west to the Missouri River in regions 25, 28, 29, 30, and the warmer parts of regions 22 and 27 (fig. 4). It needs plenty of water at all times and a fairly rich soil that can be maintained by cow manure and other animal manures if at least partly composted.

CAMELLIAS

These plants, but especially *Camellia japonica*, are known in the South as japonica. They are entirely different from Japan quince (*Chaenomeles lagenaria*, at one time *Cydonia japonica*), the plant which is called japonica in the North. Camellias are adapted to portions of the South, notably regions 29, 30, and 31, as shown in figure 4. They require an acid soil and partial shade, as described for rhododendrons, and are especially successful in sandy soils with cow manure as fertilizer.

CAPE-JASMINE

Cape-jasmine (*Gardenia jasminoides*, *florida*, and *veitchi*), is a valued ornamental shrub and hedge plant in the Southeastern States in regions 29 and 30 (fig. 4), the warmer half of region 28, and a small portion of region 25. It needs an acid soil and appreciates some shade.

CRAPEMYRTLE

Crapemyrtle (*Lagerstroemia indica*) is one of the summer- and fall-flowering shrubs that is widely grown throughout the South, but is not hardy north of Washington, D. C., Cincinnati, Ohio, and St. Louis, Mo. It is suited for culture in regions 3, 5, 10, 11, 17, 29, and 30 and the warmest parts of 16, 20, 25, and 28 (fig. 4). At Washington, D. C., it sends up shoots from the roots if it is killed to the ground. Severe pruning before growth starts in the spring results in larger trusses of flowers that season. When it is grown where it is at all tender, it is best to wait until spring to prune it (fig. 34). It responds to pruning in much the same way as does the hardy garden hydrangea, giving larger, more showy trusses if severely pruned.

FLOWERING CRABS

The foliage of flowering crab apples and thorns is probably more subject to leaf diseases than the foliage of most of our ornamentals. Where these plants are used for their ornamental fruits as well as their flowers it is desirable to plant more than one kind, if named

varieties are used, as frequently these plants do not produce the desired fruits unless pollinated from another variety.

DOGWOOD

Flowering dogwood, a white species, is native over much of the United States; occasionally a pale pink one is also found. Both white and deep-pink kinds can be purchased from nurseries. These nursery-grown plants are successfully moved at the appropriate season for other deciduous plants with only moderate pruning. Many dogwoods are collected from the wild and the mortality is high. This loss is due to the operation being attempted too late in the spring after growth has started; too few roots are obtained with the plant, and not enough top is pruned away to compensate for the root loss. From three-quarters to nine-tenths of the top will usually need to be cut away. An occasional good soaking may be desirable after transplanting; frequent moderate waterings are inadvisable. An occasional soaking in dry times for a few years is also recommended. The dogwoods prefer a moderately acid soil, so lime and wood ashes should be kept away unless the soil is sufficiently acid for mountain-laurel and rhododendrons. When the trees are established, a mulch is better than cultivation.

HOLLIES

Several kinds of holly are cultivated as ornamentals, some being deciduous and some evergreen. All species bear berries, most kinds having red ones, but only part of the trees bear berries, as the pistillate flowers are borne on one plant, the staminate on another. Both kinds must be in proximity if there are to be any berries. Apparently the pollen carries quite a distance. One staminate tree is sufficient for four to six pistillate trees if they are within 400 or 500 feet of one another without intervening obstructions. A few of them are native in the eastern part of the United States. They prefer light, slightly acid soil, but are of easy culture where they are hardy.

Of the evergreen species the American holly may be grown in regions 1, 2, 28, 29, and 30 (fig. 4); the yaupon in regions 1, 29, and 30; the inkberry, gallberry, or winterberry, in regions 1, 2, 25, 28, 29, 30, and most of 22 and 27; the Japanese holly in regions 1, 2, 25, 28, 29, and parts of 22 and 27; and the English holly in regions 1, 2, 3, 5, 28, 29, and 30. The deciduous common winterberry or black alder is suited to regions 1, 2, 21, 22, 23, 24, 25, 26, 27, 28, 29, and part of 30, and the smooth winterberry to regions 22, 24, 25, 27, 28, and part of 29. The Japanese holly and the inkberry have black berries.

HARDY GARDEN HYDRANGEA

The hardy garden hydrangea (*Hydrangea paniculata grandiflora*), nicknamed by nurseryman P. G. (peegee) hydrangea, is sometimes called peegee hydrangea. It should be especially pruned for the result desired; if severely pruned (fig. 43) it will produce a few huge trusses of flowers on long stems that bend over with their weight; if slightly pruned there will be many smaller trusses, many of which are held more or less erect as the stems are shorter and the trusses lighter; intermediate pruning produces intermediate results.

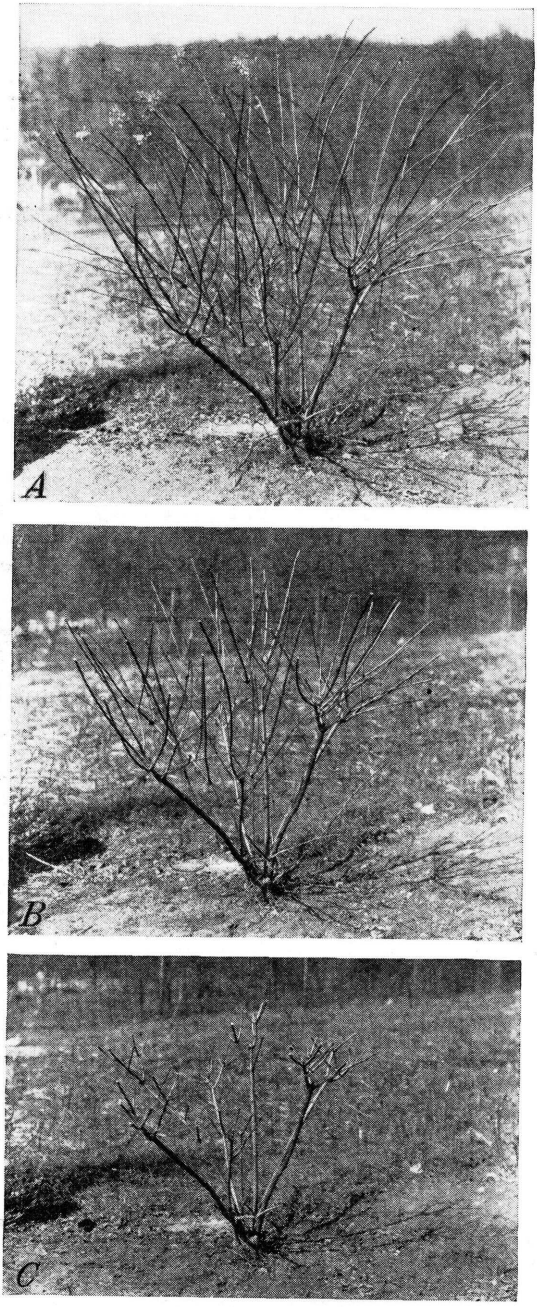

FIGURE 43.—*Hydrangea paniculata grandiflora*. *A*, Unpruned, showing the long shoots resulting from the previous year's severe pruning. Large trusses usually accompany such vigorous growths, and the few that have overwintered on the plant suggest this. *B*, Trimmed to produce a large number of moderate-sized trusses. *C*, Trimmed for large trusses. Note that the trimming has been within 6 inches of where growths started the previous year.

LILACS

The common lilac (*Syringa vulgaris* and its numerous varieties) will succeed from Canada as far south as ice of sufficient thickness to hold the weight of small boys forms on shallow ponds—in regions 1, 2, 4, 6, 7, 8, 12, 13, 14, 15, 16, 18, 19, 21, 22, 23, 24, 25, 26, 27, and part of 28. Farther south they are not likely to be satisfactory, but they succeed in regions where the crapemyrtle will not grow or is frequently injured by cold.

The lilac frequently fails to come into flower satisfactorily; sometimes as many as 10 or 12 years elapse before it blooms. Like other spring-flowering shrubs, pruning in winter or spring which removes the flower buds prevents flowering. Many unpruned specimens also fail to bloom even in regions where lilacs thrive.

Transforming a nonflowering lilac into a flowering one is done by checking a too-vigorous growth in such a way as to transfer the energy previously expended on vegetative development into the formation of flower buds. Begin by cutting the tips from new growths just after the flowering season, and remove excess sprouts, if there are any, from the roots. Permitting two or three to grow would not be objectionable. In 2 or 3 weeks new shoots that have grown from side buds since the previous pruning should have nearly half their length removed. This should be repeated until about the first of August in the States bordering Canada and soon after the middle of August in those States that mark the southern limit of successful cultivation of the lilac.

The plants should not be allowed to suffer from drought during August, September, and October, when the flower buds for the next spring are forming.

If the above treatment for a year or two does not produce the desired results it may be well to further check growth just after flowering time by spading about the plant at a distance of 12 to 18 inches, depending on its size, and cutting all its roots. Here, too, conditions for growth should be favorable at the time flower buds should be forming, but not so stimulating as to induce vegetative growth instead of the formation of the desired buds.

Manure should be kept from nonblooming lilacs growing in good soil until they have developed the flowering habit. Usually they are in good soil and are growing too vigorously. Lilacs in poor soil, if they grow at all, usually form plenty of flower buds, though the flowers and trusses may be small. More fertility will increase their quality.

Hybrids of the common lilac seldom develop this nonblooming habit; often they grow unsatisfactorily or languish and die. This is usually the result of grafting the lilac on privet and is due either to too-shallow plantings, which prevent the lilac from forming roots above the graft, or to the natural slowness of the variety in putting out roots of its own.

NORWAY MAPLE

Norway maples (*Acer platanoides*) are so densely foliaged that practically no sunshine can get through the top. This, combined with the shallow rooting that is characteristic of all maples, makes it extremely difficult to maintain grass or other ground cover under

them. It is therefore desirable to grow these trees for ornament rather than as shade trees with their lower limbs resting on the ground like beeches, firs, and spruces; when so grown they are very handsome.

An attempt is sometimes made to use this maple as a shade tree by thinning out the top. It is naturally a low-headed tree with no leader, but the branches separate from the top of the trunk. This habit of growth makes it impossible to secure more light under the tree by giving it a higher head unless it is so trained in the nursery,

FIGURE 44.—Norway maples: *A*, A normally low head and broadly oval outline; *B*, high heads secured by setting the trees as unbranched poles 12 feet tall; *C*, a tree altered in shape after reaching maturity.

and a tree trained with a sufficiently high head to accomplish the desired end (fig. 44) would be rejected by most buyers as being leggy and ungainly.

When Norway maples with the foliage extending upward from the ground are wanted, it is necessary to secure trees that have not had the lower limbs removed in the nursery. Probably such trees can be found only in small sizes, but the result will be worth the extra time required to develop them. Norway maples have handsome foliage that is usually free from insects and diseases, so that it is worthy to be used as an ornamental tree for the lawn.

RHODODENDRONS

The large genus *Rhododendron* with its many attractive species was at one time two genera, *Azalea* and *Rhododendron*. Horticul-

turally the distinctions remain, although the culture of the two groups is the same.

Both groups require a well-drained but retentive acid soil. They do not thrive in alkaline soils, and applications of lime are injurious and may be fatal. Investigations indicate that a pH reading of 5.5 is probably most favorable, although they are successfully grown with the pH reading as low as 5 if the soil is well drained, and as high as 6. A continuous mulch should be maintained, as fully described on page 36 under Soil Acidity, but all weeds should be pulled. The bloom of rhododendrons and azaleas is very profuse with an abundance of sunshine, but their foliage is best in shade. Moderate shade from tall deciduous trees is especially favorable to them.

With the azaleas of gardeners are included practically all the deciduous species of *Rhododendron* and most of the dwarf evergreen kinds and at least one that is tall-growing. The foliage of the evergreen azaleas is hairy and usually softer and smaller than that of the rhododendrons of gardeners.

The hardiest azaleas are deciduous, *Azalea canadensis* (*Rhododendron canadense*) being hardy even in Newfoundland. Among other hardy ones are swamp azalea (*R. viscosum*); downy pinxterbloom (*R. roseum*), the northern form of the Piedmont azalea; pinxterbloom (*R. nudiflorum*); sweet azalea, often called smooth azalea (*R. arborescens*); flame azalea (*R. calendulaceum*). The more tender ones are pinkshell azalea (*R. vaseyi*) and the Piedmont azalea (*R. canescens*); while in region 30 (fig. 4) there is the summer-flowering *R. serrulatum*.

Evergreen azaleas are rather more tender, though the Amoena azalea (*Rhododendron obtusum amoenum*) is hardy as far north as Boston near the coast in well-protected and otherwise favorable locations. Somewhat more tender, but succeeding as far north as many places on Long Island, are Kurume azaleas (*R. obtusum japonicum*), including *Azalea hinodegiri* and the Torch azalea (*R. obtusum kaempferi*). Other azaleas that thrive from southern New Jersey southward are the Chinese azaleas (*R. molle* and the many hybrids of *R. molle* and *R. japonicum*), the Snow azalea (*R. ledifolium*, *R. mucronatum*, or *R. indicum album*), Yodogawa azalea (*R. yedoense* or *R. poukhanense yodogawa*), and innumerable Kurume azaleas.

Along the coast southward from Charleston, S. C., and westward along the Gulf of Mexico most of these evergreen azaleas thrive as well as some of the deciduous ones, but the vigorous, large-growing Indian azalea, with its numerous varieties and wide range of colors, excels all the others and is a most magnificent shrub deserving of being grown even more widely than it is.

Garden rhododendrons are practically all evergreen and relatively large growing with large leaves without hairs. The older varieties are largely derived from the Pontic rhododendron (*Rhododendron ponticum*). The newer kinds are most of them from *R. catawbiense* and are better suited to American conditions than the older kinds. The native *R. maximum* is also an excellent species; few varieties have been developed from it, but it is worthy of extended planting. This is the hardiest of the garden rhododendrons and can be used from New England into northern Georgia (regions 27 and 28, fig. 4), but it is not adapted to the warmer regions near the southern coasts.

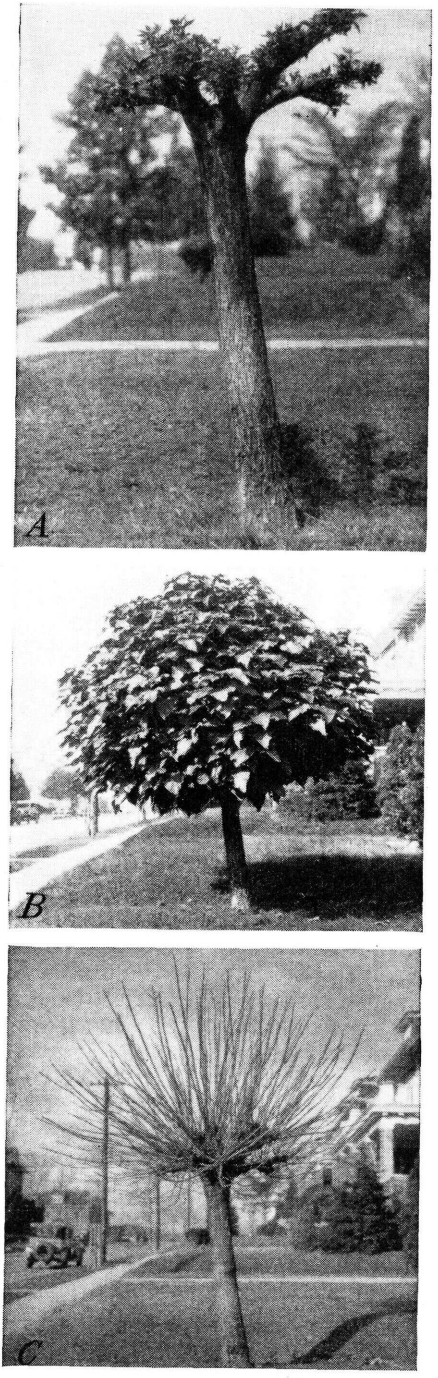

FIGURE 45.—Umbrella catalpa: *A*, After the spring pruning; *B*, as it appeared after the season's growth; *C*, as it appeared after the foliage had dropped.

The *catawbiense* varieties are not suited for growing as far north as *R. maximum*, but are suited to the warmer parts of regions 27 and 28. The *R. ponticum* hybrids are adapted to region 28.

All of these azaleas and rhododendrons are suited for cultivation in regions 1 and 2 if supplied with moisture and shade.

UMBRELLA-TREES

Some kinds of trees are popularly called umbrella-trees. The most conspicuous of these in the North is the umbrella catalpa, *Catalpa bignonioides nana*, widely but erroneously called *Catalpa bungei;* in the South the Umbrella China or Texas umbrella-tree (*Melia azedarach umbraculifera*). The Camperdown elm (*Ulmus glabra camperdowni*) also assumes something of an umbrella form when grafted 6 or 8 feet high on straight stocks, and the tabletop elm (*U. glabra pendula*) has horizontal branches with drooping branchlets that also somewhat suggest an umbrella when grafted high.

Of these trees, the umbrella catalpa is the only one that is often severely pruned. It is kept in small formal outline by annual severe pruning (fig. 45), the shoots of one season's growth being cut back 3 to 4 inches before growth starts the next spring.

In addition to the trees just mentioned there are many trees with drooping branches that are described as weeping trees.

WEEPING TREES

Many genera of trees have species or varieties that have pendulous branches that are appropriately called weeping trees. The best known is probably the weeping willow. Others are weeping Japanese cherry, the weeping birch in the North, and Teas' weeping mulberry grown over much of the country. The Camperdown elm has drooping branches, and the tabletop elm has horizontal branches with drooping branchlets, both making low trees with a drooping effect when grafted 6 or 8 feet high.

Teas' weeping mulberry when grafted on stocks 5 or 6 feet high will develop into an almost tentlike top, the branches eventually reaching the ground.

Tree roses are likewise weeping trees, climbing roses being grafted on erect stems from 4 to 7 feet from the ground and the branches drooping from these tops.

Texas umbrella-tree or Umbrella China and Umbrella catalpa are spreading or umbrella-shaped trees that are discussed under Umbrella-Trees.

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